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UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE



FOREST RESEARCH
ACTIVITIES



FOREST MANAGEMENT
WATERSHED MANAGEMENT
FOREST PRODUCTS

FOREST ECONOMICS
RANGE MANAGEMENT
FOREST SURVEY



DEC 1938



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FOREST RESEARCH

BI-MONTHLY REPORT

December 1, 1938

FOREST RESEARCH
BI-MONTHLY REPORT
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GENERAL

Allegheny

Cooperation and public relations. Lively interest in forest research is being shown in the anthracite coal region of Pennsylvania. At the request of the Wilkes Barre-Wyoming Valley Chamber of Commerce, Forbes addressed the local Kiwanis Club on the research needs of the anthracite region, and later helped the committee line up a program of activities. The immediate objective is forestation of the culm and rock banks which disfigure an intrinsically beautiful territory having a large industrial population, and which contribute a heavy silt load to the highly important streams originating there. Professors Schramm and York of the University of Pennsylvania are actively participating with us and the Susquehanna Collieries Co. in some exploratory studies of culm bank forestation.

Forbes presided at a conference on the plane-tree disease called by the Pennsylvania Bureau of Plant Industry. The conferees reported alarming losses from the disease not only in Philadelphia and its environs, but in Baltimore. Identification of the causal organism, a Cercotostomella, has been made by Dr. Jackson, who has also inoculated healthy trees with the disease, which is generally fatal within a year of the appearance of its first symptoms. The disease is probably at work in the District of Columbia, and possibly at points distant from the present center of infection. The conference authorized a committee to push the financing of an immediate study of the disease at the University of Pennsylvania, and strengthening of the research attack on this and other tree diseases in this territory.

Branch Stations. The Eastern Shore Experimental Forest, Wicomico county, Maryland, was turned over to the Station by the former Resettlement Administration. There are 996 acres in actual Federal ownership now and three or four hundred acres more are under option. The Soil Conservation Service, under whom the submarginal land work is now being handled, plans to continue the developmental work for the present. The tract is largely in loblolly and other hard pines.

At the Research Center construction has started on the new headquarters buildings. A special organization has been set up to handle the construction work at the Center and the Washington Office is generously handling, for the Station, the interbureau cooperation necessary for the supervision of the job.

Appalachian

Meetings. C. R. Hursh attended the meeting of the Highway Research Board of the National Research Council, Washington, D. C., November 28 to December 1, and presented a paper at the joint meeting, Roadside Development, Design, and Maintenance.

California

Fires. Besides the power-line fire which burned part of one of our most cherished watersheds at the San Dimas Experimental Forest, as described in the Influences section of this report, another shortly after, and equally unprecedented, reached and destroyed part of our beds and seedling stock at the Devil Canyon nursery.

Much more widely disastrous was the terrible Santa Monica Mountains fire which started from a householder dumping hot ashes and, simultaneously with the fires burning Experiment Station areas, seared thousands of acres through the Malibu Hills. It burned clear to the ocean beach and southward to the neighborhood of the city of Santa Monica. More than 50 homes, running in value from \$50,000 to \$250,000 each, were destroyed. And at almost the same time a fire in the San Bernardino Mountains destroyed the million-dollar Lake Arrowhead resort, together with many summer homes. The Station will be called upon to help in the immediately urgent job of minimizing the erosion damage which can hardly be avoided from the winter storms that are now to be expected at any moment.

Intermountain

Personnel. Lincoln Ellison has been since July in charge of the Great Basin Branch transferring from the Northern Rocky Mountain, following a year's graduate work in plant ecology at the University of Minnesota.

Ellison will conduct investigations in range ecology and range revegetation, and as superintendent of the branch station he will also facilitate the studies in range reseeding, forage utilization, and erosion run-off.

Lake States

Dedication of New Quarters. Green Hall, the new home of the Division of Forestry and the Lake States Forest Experiment Station, was dedicated November 18, 1938. Among the speakers on the day's program and banquet which followed were F. A. Silcox, H. H. Chapman, C. L. Forsling, and Ellery Foster, Minnesota State Forester.

Visitors. Colonel Stevenson and Mr. Cram of the Manitoba Forest Service, who were working on a cooperative fire-protection plan with the Minnesota State Forest Service, visited the station during November. The Lake States fire danger meter intrigued them and they requested 25 meters for trial in Manitoba, where conditions are much the same as in this region..

Public Administration. The Forest Service and the factors that played an important part in its development were the subject of a talk given by the Director at a luncheon meeting held by the Public Administration Training Center of the University of Minnesota. In his analysis of why the Forest Service succeeded as a public institution, the following points were emphasized:

1. Capable leadership was devoted to the cause.
2. The conservation movement was not only timely but it furnished an ideal worth fighting for.
3. A high type of personnel was attracted to its service.
4. Decentralization was the keynote of organization.
5. Members were public servants and a sympathetic understanding of the people's problems was insisted upon at all times.
6. Freedom of expression was always allowed within the service.

At the present time, unless the spirit of the organization is maintained, there is a real danger of the Service, with a personnel reaching into the thousands, succumbing to the "curse of bigness."

Meetings. The work of the Superior Branch Station was reviewed at a two-day investigative "meeting" held on the Superior National Forest on October 10 and 11.

The following general conclusions were reached:

1. Benefits of plantation care have been demonstrated and the results will be applied to national-forest practice.
2. Principles of jack pine reproduction have been pretty well worked out and are already finding application on the national forest.
3. There is need for further study of black spruce silviculture.
4. Nursery problems need attention.
5. A high degree of integration exists between the research program of the Superior Branch Station and the silvicultural and reforestation practices of the Superior National Forest.

Northeastern

Meetings. The annual meeting of the Northeastern Forest Research Council was held in New Haven, Connecticut, on December 1 and 2, 1938. Fifteen Council members and guests as well as most of the station staff attended. The first session was devoted to discussion of research losses in the hurricane of September 21, 1938, problems created, and possible research contributions to hurricane salvage and forest restoration; during the afternoon C. E. Curran of the Forest Products Laboratory, spoke on opportunities and limitations in secondary utilization of forest products in the region. In the evening a report by Mr. Lockard on the first season's operations of the Otsego Forest Products Cooperative Association drew favorable comment and considerable discussion. On the second day of the Council meeting, Dr. Schreiner gave an illustrated talk on the progress of forest genetics; Mr. Bevan discussed inter-bureau handling of flood control surveys; and Mr. Roberts gave an illustrated progress report on the Merrimack flood control survey.

Hurricane Losses. Director Winslow and Mr. Sweet, of the Forest Products Laboratory, spent a week in New England to become familiar with conditions in the hurricane zone and to consider ways in which the Laboratory could be of assistance in working out problems of hurricane salvage. The Station and the Laboratory assisted the New England Timber Salvage Administration in Boston in the formulation of log grading rules to be used as a standard in purchase of windthrown timber. The production cost studies, which had been made by the Laboratory and the Station for both white pine and northern hardwood, proved invaluable in this connection. The tentative rules used in the white pine study were modified slightly in the light of the results of that study and simplified for use in the timber salvage project. Data supplied by the Station and the Laboratory on lumber grade output from the different log grades were also helpful in deciding upon prices to be paid.

Immediately following the hurricane of September 21 a survey was undertaken to appraise the damage done to the Station's experimental work. All permanent sample plots lying in the hurricane zone were visited. Cruise plot estimates were made of the timber losses on both the Bartlett and Gale River Experimental Forests, which were the only two of the Station's six experimental forests seriously affected by the hurricane.

Of 473 plots lying within the hurricane zone, 80, or approximately 17 percent, were so severely damaged as to require their abandonment. On an additional 13.1 percent, or 62, damage was of such character and severity as to necessitate setting up new objectives to justify their retention, while on 97 plots or 20.5 percent it is possible to maintain or retrieve the original objective.

Nearly 50 percent of the plots escaped practically undamaged. The white pine management project suffered the heaviest loss. On only 6 out of 51 plots can the original objective be maintained. Of the remaining 45 plots 25 must be abandoned; on 20 the objectives must be altered.

Plantation plots escaped with minimum damage. The bulk of the plantings are 4 to 6 years of age; hence of a height not subject to serious damage. Nevertheless, plantings near the center of the storm path were encountered where a high percentage of the trees were leaning at angles in excess of 45 degrees.

Both the Gale River and Bartlett Experimental Forests suffered serious damage. Of the original 12,300 cords of softwoods and 15,700 cords of hardwoods present on the Gale River Forest, approximately 3,000 cords of softwoods and 4,000 cords of hardwoods were lost during the hurricane of September 21, 1938. This constitutes approximately 25 percent of both the hardwood and softwood growing stock. On the Bartlett Forest losses were less severe. Hardwoods were damaged to the extent of about 9 percent and softwoods about 11 percent, resulting in a loss of approximately 6,500 cords of hardwoods and 1,100 cords of softwoods. Heaviest damage on the Bartlett Forest occurred on the high slope compartments where damage reached a maximum of 35 percent for softwoods and 18 percent for hardwoods. Actual losses as revealed by this survey are about twice as great as originally estimated.

Although there was considerable wind damage in the vicinity of the Oxford Nursery located at Frye, Maine, the losses in plantations of the new hybrid poplars were insignificant. Only twenty-two scattered trees in 10 and 11-year old plantations were tipped over (none were broken) and these have been cut for physical and chemical studies of the wood.

Pacific Northwest

Visitors. Dr. J. A. von Monroy, chairman of the German Technical Committee in the Department of Forestry was a recent visitor at the Station. Dr. von Monroy, who is in this country as a guest of the Oberlaender Trust, was renewing contacts made about ten years ago, and checking the progress made in wood utilization. He was especially interested in man-hour outputs in the various phases of the utilization industries, with the effect of machinery on output and on employment, and in the trend of logging and milling equipment coincident with a shift to smaller timber.

Rocky Mountain

Personnel. Leadership of the Division of Forest Influences was assumed October 1 by H. G. Wilm. Wilm was formerly with the California Forest and Range Experiment Station, working in watershed management research on the San Dimas Experimental Forest.

Manitou Experimental Forest Headquarters. Rapid progress is being made on headquarters facilities for the Manitou Experimental Forest. The office-laboratory building, two warehouse-garages, and water, sewage and power systems have been completed. Exteriors of a dwelling and a large combination conference-dormitory structure are complete and the interiors will be finished this winter. Installation of watershed controls will be carried on coincidentally with headquarters construction.

FOREST ECONOMICS

FOREST SURVEY

Appalachian

Inventory

The line-plot field work was completed for the mountain unit of North Carolina early in November. As no funds were available for extending the work to other units, the field organization was disbanded and the men were dismissed.

The field work has been completed in South Carolina and North Carolina, which together comprise approximately 45 percent of the 120 million acres in the Station's territory. Virginia, West Virginia, Kentucky, and Tennessee are still to be surveyed.

Depletion

The field canvass of wood-using industries to ascertain their raw material requirements was completed in November. Morrill spent ten days in Washington checking the Survey records of lumber production with those of the Bureau of the Census and participating in the joint discussions of Forest Service and Bureau of Census representatives regarding cooperation of the two agencies in obtaining more accurate records of production.

A trial cooperative agreement has been made whereby this Station will receive, check, and edit the North Carolina census questionnaires of lumber production for 1938. This project and similar ones being conducted by the Lake States and Southern Forest Experiment Stations may be the forerunner of cooperative agreements for the total territories of these stations to the mutual advantage of the Forest Service and the Bureau of the Census.

Interpretation

Preliminary tabulations for the mountain unit of North Carolina show that 66 percent is forest land (exclusive of the area in the Great Smoky Mountains National Park). Distribution of the forest land by site, condition, and type is shown below:

| Site | <u>Percentage of forest area</u> |
|------------------------|--------------------------------------|
| Site 1 (Good) | 10.5 |
| Site 2 (Fair) | 77.8 |
| Site 3 (Poor) | 10.2 |
| Site 4 (Noncommercial) | <u>1.5</u> |
| | 100.0 |
| Condition | |
| Sawtimber size | |
| Old growth | 10.9 |
| Second growth | 36.5 |
| Under sawtimber size | |
| Second growth | 48.9 |
| Reproduction | 3.0 |
| Clearcut | <u>.7</u> |
| | 100.0 |
| Types | |
| Yellow pine | 22.7 |
| Other softwood | 7.7 |
| Cove hardwood | 7.9 |
| Upland hardwood | 60.5 |
| Northern hardwood | <u>1.2</u> |
| | 100.0 |

Lake States

Interpretation

The problem of how to present the situation of the northern

hardwood industry to the Joint Congressional Committee was discussed at the annual Michigan Land Utilization Conference. The general opinion among the lumbermen and foresters attending the meeting seemed to favor public acquisition as a means of stabilizing the industry. The station was represented by Zon and Cunningham. /

A preliminary summary of the forest survey data for the area indicates that the industry, with a capital investment of \$150,000,000 and employing 60,000 men, is jeopardized if present trends are continued. At most, a 20-years' supply of timber remains, after which, if clear cutting continues, little merchantable regrowth will be found. However, at present there are two million acres of old-growth hardwoods which, under a system of selective logging, would support half of the present production on a permanent basis. A closer utilization of inferior timber and a reduction in waste would take up part of the slack in employment caused by the downward adjustment in production. Reforestation activities and other public works would probably have to take care of the rest.

Northern Rocky Mountain

Inventory

Preliminary inventory reports have been issued for 13 counties, completing the series for northeastern Washington and North Idaho. Forest land covered by these reports amounts to 12,974,000 acres, approximately 35 percent of the region's total.

Depletion

The fire depletion study in Spokane County shows for the five-year period, 1931-35, that 4,077 acres of forest land burned over annually, of which 1,007 acres was deforested. Average annual loss in sawtimber stands was 32 acres deforested, 246 M board feet (Scribner) or 52 M cubic feet of timber killed. In pole, seedling and sapling stands the area annually deforested amounted to 975 acres; volume killed amounted to 777 M board feet (Scribner) or 333 M cubic feet. Cubic foot values are for trees larger than 5" d.b.h. to a 4" top. For all classes of timber the average annual kill was 1,023 M board feet (Scribner) as compared with 448 M board feet reported by the State Forester.

Growth and Yield

The white pine normal yield table growth correction factor study was completed by Girard, from Washington and Cummings. These data show correction factors for growth on understocked areas varying inversely with stocking percent. The following table shows the corresponding board-foot growth correction factors for given stocking

percentages:

| <u>Percent stocking</u> | <u>Correction factors</u> |
|-------------------------|---------------------------|
| 20 | 2.30 |
| 30 | 2.05 |
| 40 | 1.85 |
| 50 | 1.65 |
| 60 | 1.45 |
| 70 | 1.30 |
| 80 | 1.15 |
| 90 | 1.05 |
| 100 | 1.00 |

Growth rates on poorly stocked areas are relatively faster than on well-stocked areas. For example, on an area only 30 percent stocked, the growth is 2.05 times the normal yield table estimate, while growth on an area 100 percent stocked is equal to the normal yield table estimate. Average correction factors have been determined for the major forest types and are approved for adjusting Forest Survey growth estimates.

Pacific Northwest

Inventory

Two large Douglas fir operators are making a detailed inventory of their cut-over and second-growth lands. In both cases our assistance was requested in making working plans and getting started. One of the survey staff spent several days at each operation. Results of this work will be available to the survey in revising inventory figures for counties in which these operations are located.

During the five years that elapsed between the old and new inventories saw-timber volume in Columbia County was reduced from 2.4 billion board feet to 1.5 billion board feet, a net depletion of 37 percent. Less than two-thirds of the remaining timber volume is old-growth Douglas fir. In 1938 approximately 101 thousand acres of land cut over prior to 1930 had failed to restock, which amounts to nearly 30 percent of the total forest land in the county. Analysis of the cut-over land data indicates that two-thirds of the acreage cut over between January 1, 1920, and January 1, 1930 had failed to restock by July 1938. The net increase in area of second-growth stands in the county is roughly 50 thousand acres, occurring chiefly in the 10- and 20-year age classes.

Southern

Depletion

While in Washington, Winters cooperated with the Bureau of the Census in their 1937 estimates of lumber production for the states of Texas, Louisiana, and Alabama. He also obtained from the Census transcripts of 1937 reported production for certain mills in Survey territory. Winters also called on representatives of the I. C. C. and arranged further details of cooperation with the Commission in Southern Survey drain work.

During Garver's visit, a procedure was approved for cooperation of the Station with the Census in compiling lumber and other production of forest industrial plants in the lower South.

Smith and assistants: (1) Continued their work compiling estimates of 1936 and 1937 drain; (2) made a study of volumes of timber in Southern Forest Survey territory logged by various methods, which was furnished Professor C. W. Bloom, Montana State University, Missoula, Montana; and (3) compiled 1936 drain and employment data for the State Forester of Arkansas.

Interpretation

Winters' Louisiana #2 report was reviewed by Elfredge and Garver, edited, and checked preparatory to being mailed out for review. Winters began preparation of a Unit report for Arkansas #1.

Spillers continued preparation of a Unit report for Georgia #3, the draft being mailed out for comment in the latter part of November.

Ineson, who returned to New Orleans November 17, spent the remainder of November completing a study he had begun on the employment phase of the Report for the Joint Congressional Committee. The remainder of the Naval Stores questionnaires of the Region's Naval Stores Conservation Program were received. This year's coverage is the best of any previous year.

FOREST TAXATION AND INSURANCE

Pacific Northwest

Forest Taxation

During October the report entitled "Local Government Reor-

ganization Study, Clallam County, Washington"; 70 pages, was written and is now ready for review and criticism.

In November field work was begun in Stevens County, Washington, in continuation of the local government reorganization study. This study was undertaken with the cooperation of the Northern Rocky Mountain Forest Experiment Station, as Stevens County falls within the territory of that Station. Stevens is the first east-side Washington county in which forest taxation studies have been undertaken. This county is of peculiar interest because its original timber resources have been practically exhausted and because of the very large Federal land acquisition in the county in connection with the Northeastern Washington Scattered Settlers Project and the reservoir back of Grand Coulee Dam.

DeVries visited the offices of the British Columbia Forest Service at Victoria in order to obtain first-hand information on the tax burden and carrying charges on the various classes of timber and forest land in that province. The local government organization in the productive forest land areas of British Columbia is very similar to that proposed in one of the major recommendations of the Forest Taxation Inquiry.

NEW PUBLIC DOMAIN

California

Climatic Results

In the September report (p. 90) reference was made to the difficulties which beset correlation of climate with crop growth or land use in mountainous areas having sharp topographic relief, resulting in complicated variations in meteorological conditions. With scattered weather stations, these frequent variations make the mapping of isohyetal lines by interpolation entirely unreliable.

It may be of interest that this difficulty has been solved here, without unduly laborious procedure, by the use of graphic correlation analysis with three independent variables, of which one was initially non-quantitative. All Weather Bureau stations were first entered on a map with the average annual rainfall and elevation of each. In doing this the average rainfall for short-period stations was adjusted by an appropriate correction factor based upon the data for the six stations of longest record in and adjacent to the northern Sierra Nevada area - this being done to neutralize possible undue effect upon a short-period record, for

example, of a single phase of a rainfall cycle. These weather stations were then plotted on cross-section paper with identifying numbers, on rainfall over elevation. The resulting diagram had a very heavy scatter. After drawing the curve, all the stations showing heavy scatter were indicated on the map, using red for positive departures and green for negative departures, with two different symbols for moderate and extreme departures. Inspection of the map then showed that the stations with heavy departures of the same sign were grouped in definite geographic areas, with the moderate departure stations forming transition bands around them. The stations of each separate group were then marked distinctively on the scatter diagram and they were found to lend themselves to representation by a curve segment for each such group, and all these curves were parallel to the primary curve.

Thus the non-quantitative variable was given quantitative status and intermediate points within a distinctive area could be given correct altitude for a given rainfall by readings in the area of the scatter diagram appropriate to the map location of the point with respect to abnormal or transition areas. By superposing rainfall station map over topographic contours for the area this has permitted a satisfactorily accurate interpolation of isohyetal lines. It may be noted that since the curves were linear they were checked by representing them by the equation $P = aE + b$ in which P and E represented precipitation and elevation respectively. Determining a and b and inserting, for example, the rainfall of a station on or close to one of the curves, the equation was solved for E and elevations obtained within an average of 10 feet of the recorded elevations.

Lake States

Public hearings held in five of the northern counties by the Minnesota Interim Legislative Commission on Forestry and Tax Delinquent Lands were attended by Zon and Moser. The final hearings are scheduled for December, after which the Commission's first report will be drafted. The station has contributed much of the factual material considered by the Commission and will cooperate in writing of the report.

During the past 16 years the 14 northeastern counties of Minnesota have suffered a decrease in assessed valuation of \$150,000,000 a 30.9 percent shrinkage. One county has experienced a shrinkage of 72 percent. The debt burden of local units has become increasingly heavy as taxable values have shrunk. Exclusive of iron-ore counties, debts average 29 percent of the taxable value. In Cass and Cook Counties debts are over 50 percent of taxable value. These financial difficulties have prevented definite action on the tax-delinquent-land problem. This situation has been stressed in both the

Lake States Regional Committee Reports and in the hearings of the Interim Commission.

Pacific Northwest

The idea that a large proportion of cut-over forest lands in the Douglas fir region forfeited now or in the future to counties for unpaid taxes may be seeded and put under a sod cover for grazing purposes has spread broadly among county administrators in western Oregon and is reaching county administrators in western Washington. It appears to germinate from a desire to put cut-over forest lands to some immediate use from which public revenues may be derived at an early date. Programs for placing these lands under stable ownership and definite management are being delayed and physical, biotic, and economic criteria are lacking upon which to base sound conclusions as to the best short term and long term uses of these lands.

Representatives of the national, regional, and Oregon offices of the Bureau of Agricultural Economics spent several days with Wilson revising the rural zoning measure prepared for introduction at the Oregon Legislative Assembly in 1937. At the same time broad principles were formulated tentatively in the hope that county administrators, agricultural leaders, and foresters will carry them forward to agreement.

Southern

Field work on Craig's investigation of tax delinquency in Oklahoma was completed on October 7 on completion of work in Beaver, Tillman, Jackson, and Love Counties. Township plats (scale 1" = 1 mile) showing tax status of all land have been prepared for Beaver, Jackson, and Love Counties, Tillman being omitted since the very small amount of delinquency in this county does not justify the preparation of these plats. One set of plats covering each county has been submitted to State Forester Durrell and the County Treasurer of each county has been supplied with one set covering his county. These were requested by the County Treasurers in order to assist them in preparing their list of lands for the resale to be held in April 1939. In most counties this will be the first resale since 1931.

Compilation and tabulation of field data have been completed and the formal report on the study will be finished during December.

Analysis of these data indicates that delinquency is much less severe in southwestern Oklahoma than in any other portion of the state. In the Panhandle, represented by Beaver County, there

is considerable delinquency but less than in eastern Oklahoma as represented by Latimer, Adair, and Creek Counties. In south-central Oklahoma, represented by Love and Carter Counties, delinquency is also high but still below the extent of delinquency in eastern Oklahoma.

At the request of the Division of State Planning of the Oklahoma Planning and Resources Board, Craig assisted that Division in developing plans for the conduct of the recently inaugurated study under the jurisdiction of the National Resources Committee of the location, area, use, and administration of all public or quasi-public lands in the United States. The Station will not be concerned with this study except in an advisory capacity if and when field work is started.

PRIVATE FORESTRY

Central States

Farm Woodlands.

The analysis and compilation of stand and growth information for the farm woodlands of three townships located in three north-western Ohio Counties was brought close to completion during this period.

It appears from the sampling of the farm woodlands in these three townships that the 1935 Census of Agriculture figures are over-statements of the areas therein which may be classed as woodlands. This bears out the oft-stated contention of the Station, that census data are unreliable as an authority of wooded areas in the corn-belt states. The following table shows the size of the present sample, the percentage of woodland area located therein and the 1935 Census figure for the farm woodland area of the entire township.

| | Washington Township, Auglaize County, Ohio | Eagle Township, Hancock County, Ohio | Richfield Township, Henry Co., Ohio |
|--------------------------|---|---|---|
| Sampled area (acres) | 3500 | 3504 | 3087 |
| Percent in farm wood- | | | |
| lands for sampled area | 12 | 7 | 3 |
| Percent of entire town- | | | |
| ship in farm woodlands | | | |
| according to 1935 Census | 17 | 11 | 4 |

Washington Township contains a greater area of well-stocked woodlands, nearly one-half of its wooded area containing a basal area per acre of 60 square feet or more for trees 13 inches in diameter and larger. These well-stocked woodlands averaged about 9700 board feet per acre for trees 13 inches in diameter and larger by the International 1/4-inch rule. In contrast, Eagle Township shows about 23 percent in well-stocked woodlands (more than 60 square feet of basal area per acre) and Richfield Township has no woodlands similarly well-stocked. The percentage of depleted woodlands (those containing less than 30 square feet of basal area per acre) for Washington Township is 7 percent; for Eagle Township 25 percent and for Richfield Township 33 percent.

The character of the farm population appears to have had an important influence on the retention of well-stocked woodlands in Washington Township. A preponderance of the farm people are of German extraction.

Northeastern

Farm Woodlands

Construction of the processing plant for the Otsego Forest Products Cooperative Association got under way again on November 9. The temporary mill has been sawing material for construction from logs which were carried over from last season. End coating of beech logs in the spring appears to have given very satisfactory protection against deterioration during the warm weather. Logging contracts are being signed up for this winter's operations.

Pacific Northwest

Financial Aspects

Selective Timber Management in Douglas Fir. Brandstrom spent several days on the operations of the Simpson Logging Company at Shelton, Washington, in connection with a proposed experiment in partial cutting on a certain area of company-owned land. On this area the timber consists of an almost pure stand of Douglas fir, averaging about 40 M feet per acre. Owing to low quality and generally small size, this timber, according to the company's own appraisal, could not be logged at a profit on a clear cutting basis, and it was their desire to determine if a partial cut could be made at a profit or at a lesser loss. Based upon study data gathered on this operation in 1931, Brandstrom determined that at present costs and prices trees which contain only No. 3 logs do not return their own costs unless they are 30 inches in d.b.h. and larger, and that for trees which contain a

No. 2 butt log the corresponding diameter limit is 24 inches. In accordance with these findings, the company is now liquidating only the plus-value trees, and this leaves standing a great number of trees mainly in the 6 to 22-inch diameter range. It remains to be seen whether this residual stand, much of which is of a desirable type, can be successfully protected against fire and also whether it will respond to any great extent to release. It should be borne in mind that this is purely a liquidation cut in which all present values are removed.

Selective Timber Management in Ponderosa Pine. At the request of the Regional Office, Brandstrom spent a good deal of time on an analysis of various systems of light marking for a new timber sale area on the Malheur National Forest on which the Edward Hines Company will start cutting next spring. The recommended system again calls for a 40-percent cut following along the lines previously recommended by this Station.

A brief but significant memorandum on the economics of pruning in ponderosa pine was submitted by Brandstrom. Basing his study on the Hines study data, he shows that pruning in this species promises to return its costs many times over and recommends its adoption as a C.C.C. project on the Malheur National Forest. This recommendation has since been accepted and actual pruning operations, under the guidance of the Division of Silvics of this Station, are already under way.

STUMPAGE, LOG, AND LUMBER PRICES

Northern Rocky Mountain

Stumpage price statistics for Region One have been compiled since 1912. The 1937 canvass of prices indicated that stumpage transactions in the Inland Empire continue in substantial amounts, although in relatively small amounts compared with 25 years ago. During 1937 approximately 660 million feet of sawtimber changed hands at an average of \$4.14 per thousand. White pine averaged \$6.56 per thousand compared with \$2.33 for ponderosa pine, while the top price for these species was \$8.93 and \$5, respectively. Cedar topped all species, bringing a high of \$11.30 per thousand for poles and piling when considered on a log scale basis.

FOREST MANAGEMENT RESEARCH

FOREST FIRE PROTECTION

Allegheny

Control

Little's report, as submitted to the New Jersey State Fire-warden, on "Methods of Mapping Roads and Water Supplies for Fire Protection", shows that southern New Jersey has an abundant supply of water in the form of streams, cranberry bogs and storage ponds, natural swamps, and springs. In Section 13, the sample area in which Little did his work, very few areas were found in which no water is available. If a standard is set of one water hole per mile along the roads (in the sample area that worked out to 1.8 holes per square mile), 40 to 50,000 man-days of C.C.C. labor, or approximately one camp year, would be required to develop or make accessible these holes in 43,000 acres. To develop one water hole every two miles along the roads (0.9 per square mile), 10,000 man-days would be required.

Fire weather records are now being obtained on the Lebanon Experimental Forest in New Jersey. Hygrothermographs, anemometers, and fan psychrometers have been installed in three locations: 1) above the forest canopy; 2) in a 120-foot square opening within the forest; and 3) in a forest stand. Because fire weather forecasts for New Jersey have been made in the past from records obtained above the forest, comparisons between these three stations are to be made to determine what differences exist between above-the-forest conditions and those on the ground, where fires actually start. Indicator sticks have been installed at the two ground stations. Current danger rating and danger forecast records are being made to check the new R-7 fire danger meter against south Jersey conditions. Anemometer records to date indicate 3 times as much wind movement above the forest as in the 120-foot opening on the ground and 3 times as much in the opening as in the woods adjacent. Even more difference is to be expected in the summer when the hardwoods are in leaf. Little has experienced a good deal of difficulty in getting his anemometers to check when exposed under identical conditions.

Appalachian

Control

Fire Danger Measurement. At the request of the Chief's office, Jemison was detailed to the New England hurricane area for a six weeks' period in October and November to determine how fire danger measurement might be used to guide prevention and control activities in the blow-down. Tentative plans call for the extension to the states of the danger-rating system devised by the Appalachian Station and now in use on all Region 7 forests.

The installation of fire danger equipment on the Region 7 forests will soon be completed and a detailed check of the new danger meter will be under way.

California

Behavior

The wind tunnel under construction at the time of the last report was completed in mid-October. The power unit consisting of a four-foot aeroplane propeller driven by a 4-cylinder Ford motor develops satisfactory air speeds in the test section over a range of 1.5 to 12 miles per hour. Higher velocities have not yet been attempted.

Because of more or less continuous inclement weather since completion of the tunnel, only a limited amount of preliminary data on the behavior of fires in ponderosa pine needle litter was obtained before the Mount Shasta Branch Station was closed for the winter. The few fires burned under high moisture content conditions, however, were sufficient to indicate that the forest fuel study making use of miniature fires, as reported at intervals during the past two years, can now be feasibly extended to include the wind variable.

The previous studies have indicated that the combination of fineness of the fuel and its compactness has a very definite influence upon the rate of spread of small fires burning in still air. The primary immediate objective of the extension of the study to include the controlled wind variable is to determine whether the fineness and compactness variables exert increasing or decreasing influences upon the rate of spread of fire with increases in wind velocity. This information is considered particularly important in that it should indicate the accuracy in the measurement of fuel characteristics in the field which will be required to result in satisfactory correlation of the fuel variable with fire behavior phenomena.

There are many other valuable uses to which this equipment

can be put in various fire behavior studies. One of the outstanding studies to which it can contribute materially is the study of forest fire ignition.

Lake States

Control

Fire Danger. The study of the modifying effect of forest cover on fire danger undertaken this year on the Nicolet has been handicapped by an abnormally wet season. Opportunity was afforded, however, to secure considerable data in the interception of precipitation by forest cover. An extensive check was also made of the dependability of hazard indicator sticks and of their behavior under various exposures. Results to date indicate that while the sticks are of value in research work, they are not satisfactory for field use in this Region. For not only are they subject to a seasonal loss in dry weight of as much as 7 percent, but they vary individually in their reaction to weather conditions. The value of duff hygrometers for general field use is also in question owing to the practical difficulty experienced in keeping them in adjustment and uniformly exposed.

Northern Rocky Mountain

Control

Field work at Priest River was concluded this year nearly a month earlier than usual, Hayes, Naiman, and Cline returning to Missoula the middle of November after a $7\frac{1}{2}$ months' field season. Hayes is now engaged in putting the finishing touches on his report concerning fire danger factors by altitude and aspect for publication, probably in Monthly Weather Review. Some surprising and many practical conclusions bearing on fire control planning and especially on fire dispatching are included in this report.

The annual job of checking all fire danger measurements made at 134 stations on 17 national forests is being done by Naiman and Cline. This has been found to be essential work if the fire danger measurement method, produced by research, is to be dependably applied in the field. Mere publication of a research result so often is a contribution only to the library, or is erroneously or poorly applied in the field unless the necessary extension or liaison effort is also applied. The annual checking also is real research in that it compares results at many stations and uncovers differences in conditions not considered by the original research proposal. New leads as well as refinements are found every year.

Comparable daily records of fire danger are now available for five fire seasons in the western portion of Region One and Gisborne is assembling these data in form for statistical analysis. These records constitute an excellent basis for determining the "normal" fire season length and intensity which is the logical basis for fire control financial estimates. By applying what is known as table X-1c, of the Regional fire control plans, to the normal danger curve the number of men needed and therefore the finances required, can be determined on bases of the type specified by Mr. Granger. At a recent supervisors' meeting the vote unanimously favored presenting Region One's financial needs for fire according to these indices. The soundness of the estimate rests first, however, upon the curve of normal danger. Whether or not one curve can be used for all ten western forests is a question that requires statistical examination. Economic and even philosophical phases are also involved.

At this same supervisors' meeting there was general agreement that Fire Research still has an obligation to the field in the form of personal inspection of inflammability stations to insure not only the use of proper techniques of measurements but especially to obtain comparability of station locations and exposures on the several forests. Fire danger is not an absolute quantity; it is a relative index, and extreme precision of measurement of the individual factors of danger is largely wasted unless these measurements are made at comparable general locations. The case is similar to Weather Bureau practices of measuring temperature on top of a 10-story building in the center of one city and out at the airport of another. Such measurements are not comparable.

Pacific Northwest

Control

Matthews met for ten days with a committee of Regional Office and National Forest men in the revision of the individual fire report and other fire control forms. The fire danger rating records cascaded in from the forests and were checked and commented upon. Plans were laid to make a study of fire danger station records in order to determine some of the principles that should govern the location of these stations. Contrasting pairs of stations (e.g. at high and low elevations) will be studied. Two conferences were held with National Park Service officials on fire danger rating. A comprehensive office manuscript was completed by Matthews covering the "Objectives, Problem Analysis, Status, and Working Plan of the Fire Danger Rating Project."

A fuel type map was made of the West Fork Logging Company's partial cut area of 220 acres of Douglas fir type. This map and the numerical ratings derived from it has provoked considerable

discussion about the fire hazard on partial cut areas as compared to virgin timber or clear-cut areas. One of the moot questions involves the credit to be given to tractor roads in rating resistance to control.

FOREST GENETICS

California

Breeding

Progeny Tests. During October height and diameter measurements were taken on approximately 40,000 two-year-old nursery seedlings in the ponderosa pine progeny test at the Institute of Forest Genetics. The height of each seedling times the square of its diameter will be used as a volume factor for comparing the progenies and selecting those that are to be outplanted this winter to a permanent site in the arboretum. The experiment is laid out according to the new three-dimensional quasi-factorial design, and analysis of variance is now being employed to correct the progeny means for such heterogeneity as may have existed in the nursery soil or in treatment.

Once the corrected progeny means are available for all of the 729 progenies in this experiment, Fisher's method of studying regression with several independent variates will be used to determine influence of such factors as the elevation of the seed source, the geographical location within elevational zones, the size of the seed, and the time of germination. The present analysis will serve to eliminate about 90 percent of the progenies, thus reducing to about 10 percent the number that will be used to continue the test in the arboretum.

1937 Breeding Tests. Cones resulting from the limited pollination experiments conducted in 1937 have been collected this fall. Chief interest in the data lies in the light they shed on the effectiveness of the pollination technique employed. Several interspecific crosses were attempted using Pinus echinata and P. taeda as the seed parents and chiefly P. caribaea and P. palustris as the pollen parents. Altogether 19 bags were used and enclosed 102 flowers. Although pollination was late in most cases, at least one cone set in every bag. Of the 102 flowers pollinated, 58 percent set seed. It is not known yet, of course, whether their seed will germinate. Tests to check fertility were run using 3 bags in which pollination was controlled but pollen of the same species was used. Each bag set seed and of the 16 flowers enclosed, 37

percent set seed. Tests to check technique were conducted using 7 bags in which the flowers were not pollinated. Only one of these bags and one of the 42 flowers enclosed in these tests set seed. This indicates a high degree of effectiveness of bagging technique. Improvements effected since these tests were conducted may be expected to give still better results in future pollination control experiments.

1938 Breeding Tests. Pollination activities were greatly expanded in the spring of 1938 when a total of over 2,000 pine flowers were hand-pollinated. Work was concentrated on attempts to cross different species within the important relationship group *Austrocedrus*, with the hope of inducing hybrid vigor and combining in the new forms the desirable attributes of two different species. The species that were intercrossed in various ways were chiefly *Pinus ponderosa*, *P. echinata*, *P. taeda*, *P. caribaea*, *P. palustris*, and *P. jeffreyi*. As all of these species require two years to mature their seeds, preliminary results will not be available until the fall of 1939.

In addition to these crosses of different species, controlled-pollination and wind-pollination tests were started in a few groups of native trees of *P. ponderosa*. One of the objectives is to ascertain, if possible, the unknown pollen parents responsible for the most vigorous offspring from a group of trees. Genetics will not reach its utmost value for the practicing forester who must depend on natural regeneration until the hereditarily superior parents can be identified on the ground.

Polyploidy. Polyploidy experiments with ponderosa pine seedlings have been continued at Berkeley. The most abnormal seedlings have been obtained after prolonged treatment of germinating seeds with colchicine. A closely related substance, Acenaphthene, appears to have but little effect on the morphology of the seedling. Some experiments in centrifuging germinating seed have also been made. Only the future development of the seedlings will reveal what method of treatment is the most suitable for causing the desirable distortion of the process of mitosis that would result in polyploidy.

Segregation

Natural Hybrids. In recent years botanists in general have devoted an increasing amount of time and effort to the study of naturally occurring hybrids. Where related plants grow together in the field we may say that nature has been attempting to cross them for thousands of years. Occasionally a remote cross is consummated that man with his meager number of trials might never be able to duplicate.

By population analysis, by cytological investigation, and by genetic tests these plants have yielded much useful information. It has been demonstrated in certain plant groups that such a hybrid is more easily crossed with either of the parental species than they are between themselves, and that it is often more easily crossed with other relationship groups of the genus than is either parent.

In recognition of the value of such studies a project for field hybrid study has been included in the cytotaxonomic program of the Institute. Reports of naturally occurring hybrids between pine species have been solicited and several of these reports have been investigated. In most instances the trees in question were found to vary from the ordinary type for the locality but they were well within the range of variation to be expected in that species. However, several new localities for hybrids between the two closely related species, Pinus ponderosa and P. jeffreyi, were found, although this hybrid has been suspected for many years and has been tested more recently at the Institute of Forest Genetics, where the progeny from suspected hybrids included both parental types and recombinations.

A notable example of natural hybridization, in this case between pines of two relationship groups, occurs near Idyllwild in southern California. This tree was reported by Dr. H. L. Mason of the University of California Botany Department, who had received cones of the tree from a former student. This tree is apparently a hybrid between Pinus jeffreyi and P. coulteri as it is intermediate in many characters. The tree is large and old, in fact it is dying from the top. The bark is dark like that of the Coulter pine but has plates, and when lacerated gives off the vanilla-like odor characteristic of Jeffrey pine. The cones are large like Coulter pine but lighter in weight, the spines on the scales are much heavier than those of Jeffrey pine but lighter than those of Coulter and other characters are intermediate in nature. Whether this hybrid is fertile is not known, but the fact that squirrels had torn apart all fresh cones indicates that it is.

Near this large tree grow a number of smaller trees, perhaps half its age or less. Some of these resemble Jeffrey pine rather closely and others resemble Coulter, but many of them show intermediate characters less distinctive than the original hybrid. Perhaps some of these represent crosses of the first hybrid back to the parental species. These examples and one or two others less clear-cut lend considerable encouragement to those interested in this project of natural hybrid study, and it is possible that some of these field hybrids may prove of real value in the pine breeding program.

Propagation

Both grafting and cutting experiments with various pines were conducted at the Institute during October. Successful rooting of Digger pine (*Pinus sabiniana*) cuttings brings the number of vegetatively propagated pines to five species: *P. strobus*, *P. ponderosa*, *P. radiata*, *P. canariensis* and *P. sabiniana*.

Atriplex breweri, a dry-land, roadside shrub in Santa Barbara County, rooted 100 percent as a bench cutting in sand flats at Gill Nursery. Species of the genus *Atriplex* are usually easily rooted without treatment. *Atriplex breweri* is no exception, and may be planted on road fills or in gullies as pre-rooted stock.

MENSURATION

Allegheny

Stand Studies

Growth of Loblolly Pine. Field work began on the growth survey on the loblolly pine sustained yield project in Worcester County, Maryland. Growth of loblolly on the Eastern Shore is available from 30 years' records on a number of permanent sample plots within the 30,000-acre unit. A small random sample of the whole area is being obtained to check the applicability of the sample plot data and to obtain data on hardwoods. Some 5,000 increment cores will be measured on 40 strip plots, 1/4 chain by 20 chains in size. C. C. C. enrollees have been trained to extract the necessary cores, which are then measured by the technical personnel. The C. C. C., the Maryland Department of Forestry, and Region 7 are co-operating in making the inventory cruise.

California

Tree Studies

Cubic-foot Log Volumes in Logging and Milling Studies. For cubing individual study logs according to the Smalian formula (average basal area of the two ends x length, or sum of basal areas x 1/2 length), a set of tables was prepared some time ago for office use at this Station. Although they greatly reduce the time required to record and check the cubic-foot entries, as compared with doing the work from basal-area tables, they are still incon-

venient and slow because of their bulk.

10" x 18" Avg. dia. = 14". 14" x 16.3' = 17.4 cu. ft.
 + 1.4
 (Avg. basal area = 1.1562 sq.ft. x 16.3) = 18.8 cu. ft.

Smolian

Mathematically the relationship may be reduced to the equation -

Thus, for any given (D-d) and log length, the difference between average-basal-area volume and average-diameter volume will be constant.

Central States

Tree Studies

Black Walnut. A correlation of the estimated average clear length of stem with age, site, and original spacing was completed. The relationship of clear length to each independent variable was found to be highly significant.

Pacific Northwest

Stand Studies

The Station's study of yield of even-aged stands of ponderosa pine bore fruit in the form of Technical Bulletin No. 630. Headed by Dr. Walter H. Meyer, the author, this interregional project has provided the basis for estimating growth of even-aged ponderosa pine stands throughout the range of the species. In addition to standard yield tables, this publication includes a section on application of yield tables; another on mortality. Stand and stock tables are given in detail for each of the regions involved and also for the entire range. The coordinated height curves included make it unnecessary for timber cruisers to measure many tree heights. To apply these height charts, all the information required is age of stand and approximate site index. Coordinated range-wide volume tables are also presented with instructions for applying them to a specific stand.

Rocky Mountain

Stand Studies

Growth of selectively-cut lodgepole pine. During 1938, 40 additional plots were measured in lodgepole pine cut by the selection system, making a total of 85 one-acre plots. The 40 new plots were roughly checked against the preliminary yield table constructed last year to determine if the table was approximately correct and could continue to be used pending the construction of a final table based on all 85 plots. The check showed an aggregate error of less than 3 percent and an average deviation of approximately 14 percent. No actual growth predictions will be made from this preliminary table but it serves to bring out general facts. For example, a rough analysis of the data indicates the increment per acre annum for reserve stands of less than 4,000 board feet per acre is smaller than in stands of 4,000 to 5,000 board feet per acre, and that reserve stands of more than 5,000 board feet per acre decrease in increment as the reserve is increased. It is evident also that even with 4,000 or 5,000 board feet per acre in the reserve stand a cut

in trees large enough in diameter to satisfy the operator will not be available until 30 years after cutting.

Based on these preliminary results it is planned to leave a reserve of at least 3,500 and not over 5,000 board feet per acre in the best tree classes available and to plan on at least a 30-year cutting cycle, for the time being at least. A more careful check of the final table will give more complete information on variations by stand structure, site, etc. Long-term checks on permanent plots will serve to correct these preliminary conclusions.

REGENERATION

Allegheny

Planting

Hetzel re-examined the plantations established on the Allegheny National Forest last spring to test grades of stock, methods of planting, and species adapted to dry sites, such as hardpans. Hardpan was found to be general over the flatter portions of the National Forest "plantable" areas. An examination of root systems of thrifty and stunted trees in older plantations showed strikingly the effect of poor planting on root development. Photography was employed freely to supplement written material in a leaflet for C.C.C. planting foremen, proposed for preparation in time for the 1939 planting season.

Seed Studies

Harding's fall examination of the red pine source-of-seed experiment brought out clearly the variations in site encountered even within 5 acres on a plateau top in the Allegheny region, and justified the great care we used in the design of this important investigation.

Appalachian

Planting

Results on T. V. A. Plots. The first-year examination of about 350 experimental planting plots was completed early in November. These plots constitute about half of those contained in 8 ex-

periments conducted in cooperation with the Tennessee Valley Authority. The remaining half of the plots will be planted in January, February, and March, 1939.

Analysis of the data has not yet been completed, but first-year survival on all of the 14 species used has been excellent, well over 90 percent in most cases. One of the smaller experiments shows the following mean survivals:

| | |
|----------------|--------------|
| Shortleaf pine | 95.3 percent |
| N. white pine | 99.2 " |
| Yellow poplar | 93.0 " |
| Black walnut | 89.0 " |
| White ash | 92.2 " |
| N. red oak | 98.9 " |
| White oak | 96.9 " |
| Chestnut oak | 90.6 " |
| Red gum | 87.7 " |
| Black locust | 77.9 " |

These figures are quite typical of survival in other experiments. Due to the excellent first season, it is expected that most species and site differences, both in survival and growth, will not show up until the next few years.

Report for the Spruce Type. A comprehensive report on the analysis of the planting problems of the denuded spruce type areas in the Southern Appalachians has been completed. Tentative experiments have been designed to attack this problem. The report and proposed experiments will be used as a basis for discussion when the final program is decided upon. It is hoped that this work will get under way in the summer of 1939.

Piedmont Seed Spot Studies. The fall sowing of shortleaf pine, loblolly pine, and Virginia pine in the Piedmont seed spot studies was completed about the first of December. This study is being conducted both in the northern and southern Piedmont on good and poor sites. Besides site differences, the experiment involves various methods of seed spot preparation and an attempt to determine some of the causes of initial mortality for these species.

Seed Studies

Loblolly Pine - One-parent Heredity Study. In 1934 a study was initiated in loblolly pine, designed to show the effects of the characteristics of the female parent upon the growth of progeny seedlings. A recent examination of the field plantation made at the end of the third growing season indicated that damage by various agencies may tend to complicate the analysis.

Damage caused by white grubs (larvae of Phyllorhiza sp.), which was heavy during the first and second growing seasons, is no longer a problem. However, there is evidence that damage and mortality caused by rust (Cronartium fusiforme) may increase during the next few years. Tip moth (Rhyacionia frustrana) has caused widespread, although temporary, damage throughout the plantation. Pine leaf scales (Chionaspis pinifoliae) is at present in the plantation, but it has caused very little damage thus far.

It is anticipated that formal analysis of the data will be undertaken following the fourth growing season.

California

Planting

Planting experiments were affected adversely by the dry, open fall. Early rains were too light to permit planting. Lack of a snow cover has favored excessive rabbit damage and frost heaving.

Final winter examinations were made of the two Burney Spring brush-field plantations November 18-20. These plantations include 10,800 planted trees and 10,800 seed spots. Rabbit clipping has been severe since October 17. In the stripped brush, where there was no burning, almost every transplant and seedling has been eaten back almost to the ground. Frequently the stubs are covered with soil as a result of frost heaving. Rabbits also are invading burned portions of the area where returning vegetation two years old furnishes cover. Such severe damage is sufficient to cause failure of brushfield control, even without the aid of many other agencies.

Damage by rabbits also prohibits experiments in the brush-fields requiring comparisons in terms of growth. For this reason a test field was prepared at Feather River where rabbits can be excluded. The first test plan provided for comparisons of four planting-storage treatments of ponderosa and Jeffrey pine stock from Durbin Nursery. The treatments are: (1) Fall planting without storage; (2) Spring planting after storage in a heel-in bed; (3) Spring planting after storage in a refrigerator; (4) Spring planting without storage. Dryness of the soil required converting the fall planting to a late spring planting treatment. The stock is divided into three size-grades and half of each lot has scaly winter buds - the other half budless shoots with primary needles (Larvas shoots).

The stock for storage was lifted and graded November 21. The stock without buds averaged smaller than that with normal buds.

Conditions were unfavorable for heeling-in. The soil was dry beneath and frozen on top. Application of water probably will result in freezing to unusual depths. Soil thermographs were installed at the heel-in bed. The refrigerated stock was stored at 35° F.

Nursery

During November, germination of seed species that had not been heretofore successfully propagated from seed included: Arctostaphylos mariposa, A. drunacea, A. elegans, A. franciscana, and one species of Yerba Santa, Eriodictyon lanatum, from San Diego County. All the above seeds responded to stratification at 0° C., the Eriodictyon lanatum in a standard nursery flat for three months, and the Arctostaphylos in jars of moist peat moss that had been in 0° C. for from six to nine months.

Successful germination of the seed of Abies venusta, collected in the Santa Lucia Mountains of Monterey County last October, has produced over 400 seedlings of this species up to the present time, thus assuring the Experiment Station and the Region a sufficient supply of this rare fir tree for experimental and landscape uses. Final production of this fir should total well over 1000 seedlings.

Central States

Planting

Mortality. A significantly higher mortality was found in fall planted than in spring planted trees. Previously, much of the mortality in fall plantings has been attributed to injury from frost heaving. The greatest plot mean difference between fall and spring measurements was less than one-eighth of an inch, a difference insignificant in affecting mortality. The higher mortality in the fall test plantings is attributed to excessive transpiration in plants with poorly established roots in soil frozen for a part of the winter.

Different classes of stock responded differently to the winter conditions. Three age classes were used, 1-0, 2-0, and 1-1. There were four sub-classes in the 1-0 seedlings; (1) given no water, (2) watered one hour each day excepting rainy days, (3) watered four hours each day excepting rainy days, and (4) watered as nurseryman considered best. The 2-0 seedlings contained three sub-classes, (1) not pruned, (2) top pruned, and (3) top and root pruned. Pooling all sub-classes in each of the 1-0 and 2-0 age classes, there was no significant difference in behavior between the two ages but a highly significant difference between either of the seedling classes and the 1-1 top pruned trans-

plants, favoring the latter. However, the 1-0 class mortality mean was somewhat higher than that of the 2-0 class. Of the four 1-0 sub-classes, the "usual-watered" seedlings (class 4) survived best, slightly better than the four hour watered seedlings. The top and root pruned stock survived best in the 2-0 age class. Then the three classes of stock giving best fall planting survival performance are in descending order, 2-0 top-root pruned, 1-0 "usual-watered," and 1-1 top pruned, with no significant difference between them. The two classes giving poorest survival are in the same order, 1-0 not watered seedlings, the smallest of all classes, and 2-0 not pruned, the largest of all classes, with no significant difference between them.

In regard to survival, spring planted stock behaved somewhat differently from fall planted stock. Pooling all sub-classes in each of the two seedling classes, the descending order of survival was 1-1, 2-0, and 1-0. But when the best sub-class of each of the seedling classes is selected, the descending order becomes 1-0 four hour watered, 2-0 top pruned, and 1-1 top pruned. The poorest classes of stock in the spring planting tests remain the same as in the fall planted trees.

Increment. The spring planted stock has a significantly greater seasonal height growth than the fall planted stock. Pooling all sub-classes for both fall and spring, in each seedling age class, the descending order is 1-0, 1-1, and 2-0. Significant differences exist between the 1-0 and 2-0 and between the 1-1 and 2-0 classes, but the difference between the 1-0 and 1-1 classes is not significant. When the best sub-class of each of the seedling classes is selected, the descending order is 1-0 "usual watered," 1-1 top pruned, and 2-0 top-root pruned.

From the behavior of the several classes of stock in the Missouri Ozark plantings, it seems that 2-0 stock might well be eliminated from the planting stock for that area. Heavy culling is necessary in 2-0 stock because of the great range of height classes developing. Top pruning, which results in generally poorly formed trees, is necessary in the nursery to obtain acceptable survival. It appears that 1-1 stock may prove satisfactory for fall planting and sturdy, well-developed 1-0 seedlings for spring planting.

Fertilizer Treatments in Plantations. In a factorial design employing twenty-seven mixtures of fertilizer elements with a dolomitic filler and the similar mixtures with a peat filler significant responses to certain treatments have developed in some species. Black locust, shortleaf pine, and red cedar have responded favorably to fertilizers with dolomitic filler. White ash and yellow poplar have responded favorably to fertilizers with a peat filler. Final conclusions cannot be drawn from any

of the present data, but much has been gained in narrowing the field of fertilizer experiments involving several species.

Plantation Establishment. The objective in much of the field planting work at this station has been to obtain establishment of a forest cover on abandoned lands. In the spring of 1936, plantings of l-O shortleaf and pitch pines were made in southeastern Ohio. Criteria under test in these plantings were ground cover and aspect effects. Very definite parallel responses to various vegetation covers and aspects occurred during the first and second growing seasons. But during the third growing season, the effects of specific covers upon height increment have been much less pronounced. Differences between blocks are much more in evidence than during the first two years. For testing the relative importance of certain site factors in shortleaf and pitch pine seedlings, an establishment period of two years may be sufficient.

Direct Seeding. Pitch, shortleaf, Virginia, loblolly, white, and red pines, were included in direct seeding tests in the spring of 1938. On August 8, loblolly pine had given the highest germination. Other species in order were Virginia, white, shortleaf, pitch, and red pines. Germination for each pine was much higher on the north aspect than on the south aspect. Survival for the first season was best for pitch pine. Other pines survived in order, shortleaf, Virginia, loblolly, red, and white. Although the species with the highest germination and survival may be satisfactorily seeded directly on protected sites, better results will have to be obtained, probably through refinement of seed spotting methods, before general recommendation can be made for direct seeding.

Seed Studies

Oak. During October about 4000 white and black oak acorns were collected beneath trees on the Clark Purchase Unit and examined for defect. As was true of the 1937 acorn crop in the same locality, about 98 percent of the acorns were defective. A more careful check on cups and pieces of nuts revealed that at least 40 percent of the original crop of acorns have been damaged by animals. Other causes of defects were insects, immaturity and decay, in the order named.

A number of plots have been established for the purpose of checking on the condition of the acorns throughout the winter months on burned and unburned areas and to find out what part hogs play in reducing the number of oak seedlings in the Missouri Ozarks.

Intermountain

Planting

Ponderosa Pine. Whenever slash is burned, whether in the course of logging operations or uncontrolled fires, apparent severe sterilization of the surface soil is clearly noticeable in spots where the fuel has been heavy enough to result in a hot fire. It often takes several years for weeds or other vegetation to encroach on such "sterile" spots to any degree, despite exhibition of rank growth around borders. There is some question whether this "scorched earth" presents deleterious effects so strong that they offset the beneficial effects from the consequent reduction in surficial competition and the liberation of various minerals in the ash. To obtain some light on these questions, a series of 15 paired spots were planted in May 1938, using 2 grades of 2-0 ponderosa pine in each spot. The pairs comprised a spot on which slash had been burned resulting in severe "sterilization", and a companion spot on which the vegetation had not been disturbed. The big visible differences between the two members of a pair were the absence of surface competition and the presence of ashes and charred material in the case of the burned spot. One row of seedlings of each grade (#1 and #2) was planted in each burned and each vegetated spot. Survival counts made at the end of the first growing season are given in the table below:

Average survival percentages of 2-0 ponderosa pine.

| | Burned Spots | | | Vegetated Spots | | |
|----------------------------|--------------|----------|-------------|-----------------|----------|-------------|
| | Grade #1 | Grade #2 | Both Grades | Grade #1 | Grade #2 | Both Grades |
| Percent alive | 86 | 72 | 78 | 95 | 87 | 91 |
| Percent alive and vigorous | 81 | 57 | 69 | 90 | 66 | 78 |

Differences between grades are highly significant and are quite striking when considered on the basis of vigor rather than survival alone. True surface differences are somewhat obscured by the disproportionate amount of cattle-trampling injury suffered by the seedlings on the burned spots. The trampling injury was doubtless a contributing cause (and in several instances a direct one) to higher mortality on the burned spots. Heavy trampling appeared to be induced by the comparatively luxuriant growth of annuals and succulent perennials on the borders but not within the burned spots. In browsing the border vegetation, the cows invariably trampled on the seedlings, causing a varying amount of damage from spot to spot.

Woody Shrub Species. In the fall of 1937 and the spring of 1938 a test was started to determine methods of propagating woody shrub species which might be beneficial for controlling erosion on the granitic soils of central Idaho, where overgrazing and burning have reduced the vegetative growth to the annual weed stage and have killed most of the shrubs.

Rooted cuttings of eleven species were tried with and without growth hormones (Indol 3 acetic acid 1 percent in lanolin). No significant difference due to the hormone treatment was obtained. From 100 plants of each species, planted half in the fall and the other half the next spring, the results shown in table 1 were secured:

Table 1. - Percentage survival of shrub species planted in fall (1937) and spring (1938).

| Species | Percent Survival | |
|--|------------------|--------|
| | Fall | Spring |
| Black locust (<u>Robinia pseudoacacia</u>) | 40 | 84 |
| Rose (<u>Rosa</u> spp.) | 60 | 54 |
| Colorado juniper (<u>Juniperus scopulorum</u>) | 50 | 10 |
| Bitterbrush (<u>Purshia tridentata</u>) | 30 | 6 |
| Black chokecherry (<u>Prunus melanocarpa</u>) | 32 | 0 |
| Skunkbrush (<u>Rhus trilobata</u>) | 6 | 20 |
| Bitter cherry (<u>Prunus emarginata</u>) | 12 | 0 |
| Rocky mountain maple (<u>Acer glabrum</u>) | 2 | 8 |
| Snowbrush (<u>Ceanothus velutinus</u>) | 0 | 2 |
| Gambel oak (<u>Quercus gambelli</u>) | 0 | 0 |
| Curlleaf mountain-mahogany (<u>Cercocarpus ledifolius</u>) | 0 | 0 |

Northeastern

Planting

Activities of mice threatened disruption of the experimental plantings of genetic strains of poplar installed at the Chenango Experimental Forest the past spring. This statistically designed experiment for testing planting methods, genetic strains, and types of cuttings, involves over 22,000 poplar cuttings. An examination of one section of the experiment in mid-August showed that 17 percent of the cuttings had been worked on, to some extent, by mice. Reexamination on September 23 showed 61 percent of the cuttings had been worked on. Damage varied from negligible amounts to complete girdling of the cutting accompanied by cutting of side roots. Fol-

lowing advice from the Biological Survey, several bushels of juicy Northern Spies were diced, coated with a zinc phosphide poison, and placed in mouse runways at intervals of about ten feet. An isolation strip of 100 feet, double the usual width recommended for orchard protection, was treated also. Treatment of an isolation strip is considerably cheaper than construction of rodent-proof fence. No secondary treatment due to migration from outside areas is anticipated.

Lake States

Seed Studies

Jack Pine Seedfall. For five years the station has maintained seed traps in an open stand of jack pine at Roscommon. During this period the total fall of seed has been exceedingly small, on the average 7,000 seed per acre per year with a maximum of 12,800 in one year. That seedfall of jack pine is strongly influenced by weather is illustrated by the seed-trap record of last October.

Apparently as a result of the unusual dry spell during this month, an unprecedented heavy fall of jack pine seed occurred at the Lower Michigan Branch Station. A total of 259 seed were recovered from 37 seed traps, or an equivalent of 28,000 seed per acre. This fall of seed in one month was thus four times as great as that for the average year.

Northern Rocky Mountain

Planting

Direct Seeding. First-year examinations on the eight latin square direct-seeding plots installed on broadcast-burned areas in the fall of 1937 and the spring of 1938 by Schopmeyer have been completed. These plots were set up (1) to develop effective seeding methods; (2) to study the effect of two markedly different sites on direct seeding of different species; (3) to determine the effect of cultivation on survival, (4) to find out if conical screens placed over the spots give effective rodent protection; and (5) to obtain information on the better season for sowing. The brief summary in the following table gives a fair picture of the success of the experiments as measured by the degree of stocking at the time of the last examination in October 1938. Cultivation caused no appreciable difference in the number of successful spots; hence, data on cultivated and uncultivated spots have been combined in both the screened and unscreened categories.

Summary of stocking on direct-seeding plots installed
in the fall of 1937 and the spring of 1938

| Sandy flats in Kaniksu N. F. | | | | |
|--|-------------------|-------------|--------------------|-------------|
| Treatment | Ponderosa pine | | Western white pine | |
| | Fall sown | Spring sown | Fall sown | Spring sown |
| | <u>Percent</u> | | | |
| Spots screened | 100 ^{1/} | 65 | 87 | 32 |
| Spots unscreened | 25 ^{1/} | 10 | 18 | 1 |
| Silt loam soil on north slope in Coeur d'Alene N. F. | | | | |
| Treatment | Engelmann spruce | | Western white pine | |
| | Fall sown | Spring sown | Fall sown | Spring sown |
| | <u>Percent</u> | | | |
| Spots screened | 96 | 90 | 91 | 82 |
| Spots unscreened | 84 | 67 | 39 | 20 |

1/ Number of spots with one or more seedlings expressed as a percentage of the total number of spots sown. In the fall-sown plots there are 288 spots in each category; spring-sown plots have 192 spots in each category.

This summary, although it does not tell the whole story, definitely shows a number of facts for the particular conditions of the experiments. Of the three species studied, ponderosa pine gave the best stocking when protected from rodents by screens. Conical screens were very efficient as a means of protection from rodents. Seeds of Engelmann spruce, possibly because of their small size, were not as susceptible to rodent depredations before germination as the two larger seeded species. Fall sowing produced decidedly better stocking than spring sowing. These results are encouraging, especially in view of the fact that the 1938 growing season is regarded as drier than usual in the two forests where the plots were installed. However, in view of past seeding failures in the region, much additional work must be made to determine what part direct seeding may play in the forestation program of this region. Additional data on these and other plots will be released as it is acquired and as analysis proceeds.

Rocky Mountain

Planting

Effect of size of planting stock on survival. A study was started on the Pike National Forest in the spring of 1938 to test the effect of size of planting stock on survival under various field conditions. Planting stock was separated into the three size classes -- large, medium, and small based on the stem thickness immediately below the cotyledon scar. Diameters of the trees classed as small averaged about two-thirds and those of the large trees about one and one-half times the diameters of the medium class. The relation of the weight of the trees in the three size classes was approximately in proportion to the squares of the diameter ratio, or 0.4:1:2.3. Defective trees and runts were culled in these tests. The following planting stock from the Monument Nursery was used: Ponderosa pine 2-1, lodgepole pine 2-1, Douglas fir 3-0, and Engelmann spruce 3-1. The randomized block design was followed. Size of planting stock and planter are the only variables within blocks and site factors the only variables between blocks. The ponderosa pine blocks were located on open sites of varying exposures. On the lodgepole pine, Douglas fir, and Engelmann spruce planting sites, the degree of aspen stocking varied between blocks from zero (open) to medium (.4 density) to heavy (.7 density).

At the close of the first season, which was a very favorable one, there was survival of 70 percent for all trees. It was evident, however, as illustrated in the accompanying table, that the small trees were definitely unsuited for planting in open places. On the other hand, differences in survival under aspen cover are not significant either between size classes, species, or degree of density of cover. It is very possible that the mortality in aspen stands results chiefly from smothering of small trees by leaf litter as it was noted that at the time of snowfall all trees less than two inches tall were covered completely by leaves. Loss of small trees by smothering will be made a special phase of this study.

First year survival in percent

| Size-class | Ponderosa pine | Lodgepole, Douglas fir, & Engelmann spruce | | | |
|------------|----------------|--|--------------|-------------|-----|
| | open | open | medium aspen | dense aspen | All |
| Large | 75 | 66 | 85 | 91 | 80 |
| Medium | 73 | 49 | 88 | 85 | 74 |
| Small | 59 | 17 | 63 | 81 | 58 |
| Average | 69 | 44 | 79 | 86 | 71 |

Southern

Planting

Wakeley spent approximately a week in October with Guthrie who inspected the proposed expenditure of \$5,800 of C.C.C. money allotted to Regeneration. The inspection covered New Orleans, the Harrison Experimental Forest, the W. W. Ashe Nursery, the Bogalusa plantations, the J. K. Johnson Tract, and the Stuart Nursery. Guthrie has not as yet disapproved any of the proposed forms of guidance and advice in the field of Regeneration, which involve the employment of a Junior Plant Physiologist for nine months for service germination tests and related work; an Assistant Field Assistant for six months to make special reexaminations of plantations to guide the C.C.C. planting program and to help with germination tests; and several computers and clerks to help get out reports. The expenditure of a relatively small sum on travel and supplies is also included.

During October Wakeley visited shortleaf and loblolly pine plantations on the lands of the Southern Kraft Corporation and the Crossett Lumber Co., in Arkansas, in company with Assistant State Forester Lear. Severe mortality during 1938 seemed attributable primarily to drought, and suggestions were made, to be followed by a report, as to means of verifying the cause and of improving planting practice to counteract the injurious factor.

In November Wakeley, Gemmer, and Chapman made a two-day trip on the Kisatchie and Vernon Units with Ceremello, Planting Assistant on the Kisatchie National Forest, to discuss the brush conversion problem, a substitute for the staked row, and various factors affecting survival, on all of which the Station had agreed at the Lake City Program Conference, to take action.

Seed Studies

Miss M. L. Nelson, who has made the service germination tests at the Station for the Region 8 nurseries for the past two years, has been lining up the winter's testing work, preparing an office report on a study of seed from very young trees (EST-Infomal), and summarizing the fifteen years of preliminary seed storage studies that led to the storage at low temperature and low seed moisture content at present recommended by the Station. The summary of seed storage is being released immediately as Occasional Paper 78, to make it available as a guide in storing the seed collected by the C.C.C. in 1938.

Region 8 has made an urgent request for the Station's advice in preparing bids for seed storage plants in connection with the C.C.C. planting program. The point on which help is particularly needed is the matter of store-room humidity.

Patterson is making a reexamination of seed-source plantations. This reexamination was not scheduled in the working plan, but is necessary as a basis for comments on and revisions of a proposed seed-collection map. The map has been drawn up by Region 8 to give the C.C.C. planting program in the South a sound genetical foundation.

Southwestern

Planting

Commercial Fertilizers in Seed Spotting. In a previous experiment it was demonstrated that competition could be eliminated by the removal of a light top layer of weed and grass seed-bearing soil without seriously affecting the results. The experiment was repeated in 1938 to test this point, and at the same time furnish information on how crusting could be overcome, how much germination is improved on soil rich to moderately rich in humus versus no humus, what improvement in size of seedlings resulted from the treatment of spots with various fertilizers, and the effect of seed size on seedlings.

The new experiment consisted of planting ponderosa pine seed of three size classes separately on the following soils: (H) soil rich in humus taken from underneath the crowns of old groups of ponderosa pine trees; (G) soil which formerly supported a heavy growth of bunch grass but to be denuded and weeded during the course of the experiment; (Ap) soil taken from below the 12-inch level and treated with Amo-phos; (As) same as the preceding, but treated with ammonium sulphate; (V) same as the preceding but treated with Vigoro; and (12) untreated soil taken from below the 12-inch level to act as the check. The above comparisons formed

a block of 18 plots representing different soil and seed size treatment. Each plot was $2\frac{1}{2}$ x $2\frac{1}{2}$ feet in size, and the plots were separated from one another to a depth of 6 inches with sheet metal strips 7 inches wide. Three blocks were laid out in widely separate localities.

A tally of seedlings surviving at the end of the first season is given in the table.

Table (Summary of all blocks)

| Seed size | Soil treatments | | | | | | Total |
|-----------|-----------------|----|----|----|----|----|-------|
| | H | G | Ap | As | V | 12 | |
| Small | 25 | 13 | 1 | 7 | 1 | 1 | 48 |
| Medium | 31 | 12 | 0 | 1 | 13 | 11 | 68 |
| Large | 25 | 28 | 13 | 28 | 17 | 19 | 130 |
| Total | 81 | 53 | 14 | 36 | 31 | 31 | 246 |

The lesson learned from the experiment thus far is that when topsoil is removed in order to eliminate competition and thereby assist the rapid development of sturdy seedlings after germination, it should be done judiciously, and further, in order to safeguard results, the seed sown should be large and sound.

Inasmuch as one of the principal objectives of the experiment was to make comparisons of the size of seedlings attained under the different soil and seed size treatments and that many of the plots failed to produce seedlings, the experiment will be repeated in 1939.

Douglas Fir Seedlings Successfully Transplanted without Artificial Watering. In 1934, a small nursery for the growing of Douglas fir planting stock was established within the experimental forest near Cloudcroft, New Mexico. In the spring of 1937, the seedlings of the first year's sowing were dug for field planting. Heavy culling was necessary as many of the seedlings were found to lack the required top-root ratio. It was evident then that, unless the smaller plants could be successfully transplanted in the nursery for further development, the growing of seedlings for direct outplanting would not be economically feasible. About 12,000 "culls" were set out at the nursery the latter part of April in rows 6 inches apart with trees spaced about 2 inches in the rows. Immediately after transplanting the rows were mulched with pine needles and the beds covered with lath roll fencing suspended about

18 inches above the ground. The beds were kept weeded but no cultivating was done until early fall, at which time the mulch was removed. It was not replaced until the latter part of October, when the beds were again mulched for winter protection.

This transplanting job was highly successful; very few of the trees died, and most of the living trees put on new growth. The results obtained are especially encouraging in view of the fact that the transplant beds received very little natural precipitation before the summer rainy period. Not only was the soil comparatively dry when the transplanting was done, but it remained so for some time after. Only a little over 1 inch of precipitation fell up to the last week in June and most of this came in two good showers. The high survival is to be attributed to the indirect influence of factors that tend to control moisture loss. First of all, it should be mentioned that the soil at the nursery is a clay loam, in itself very retentive of soil moisture. But probably of more importance is the fact that the seedlings were dug while they were still dormant, and that air temperatures remained low for some time following transplanting. The mulch placed between transplant rows helped, of course, to conserve soil moisture, and shading of the beds tended to retard early top growth and to check transpiration.

Aside from the beneficial influence of these treatments, the character of the seedlings transplanted should be taken into consideration. At the time of transplanting they were already several years old and, therefore, better fitted to cope with adverse conditions than the usual run of seedlings transplanted in nurseries.

Nursery

Fort Bayard Arboretum. Since 1919, the Fort Bayard Arboretum, planted in 1916, has been abandoned, nevertheless, the trees have continued to thrive. An inspection of the arboretum made by a member of the Southwestern Station on September 19, 1938, showed several interesting things:

Of the native species, junipers have done better than the pinons; most of the latter, in fact, have died. Those still living have a stunted appearance. Of the junipers, J. scopulorum looks thriftiest.

Of the exotic species planted, Arizona cypress is by far the thriftiest and has also made the best growth. Chinese arbovitae has made good growth, the trees averaging about 10 or 12 feet in height. Of the four or six redwoods originally planted, only one is living. This tree at present has a diameter of about 7 inches (breast height) and is about 16 feet tall. The single living specimen of western yellow pine (Pinus scopulorum) also

appears to be quite thrifty and is about 14 or 16 feet tall.

All species, except pinons, have borne seed in the past 4 or 6 years. Even the redwood has produced a few cones but it is doubtful whether the seeds are fertile. A few of the arbovitae and junipers have mistletoe.

SILVICULTURE

Allegheny

Silvics

Total age data for the 10 plots in East Tionesta (virgin timber) are now complete and have been graphed to show the periodicity of establishment of the chief species on each plot, by decades. This has suggested that hemlock in particular is subject to a periodicity of establishment only to be explained by such widespread and powerful climatic phenomena as the great droughts, fire, or winds of hurricane force. All 10 plots were combined to secure a graph of age distribution by decades for each species represented. Beech has a characteristic all-aged distribution but hemlock has come in during certain favorable periods. While all plots on the unburned north-facing slopes and plateau south of the main stream show similar periods of abundant or low hemlock establishment, three plots on the south-facing slope, which have been subject to past fire damage, show a different periodicity related to the influence of these ancient fires and of windthrow which apparently spared those plots on the other side of the valley. A tabulation of all droughts recorded in available literature, dates of great fires in the northeastern United States and Canada, and a careful study of references dealing with tree ring growth and past climatic conditions has been made. Dr. Abbott of the Smithsonian Institution in an analysis of Dr. Lyon's hemlock growth data from Fairlee, N. H. suggests that 23, 46, and 92 year cycles are to be found and connects these with long term fluctuations in solar radiation. A table of the dates or periods of good and poor growth based on these cycles has been made for comparison with our data on tree establishment.

Appalachian

Stand Improvement

Effect of Work by C. C. C. Field work on a study of the results of the timber stand improvement done during the first years of the C.C.C. program was begun when two men from Region 8 reported to the Station early in October. This study is being conducted co-operatively by Regions 7 and 8 and the Station, and field work will be done on all the national forests in the mountain section of the Station's territory.

Stem analyses of crop trees are being made to compare growth in height and diameter for the period since treatment with growth during a similar period before treatment. Work is being confined to the younger age classes and only crop trees 5 inches d.b.h. and less are being studied. The effectiveness of the release of crop trees is being measured by a tally of all trees at present within six feet of crop trees. This competing vegetation is being separated into (1) trees not cut in the cleaning and (2) sprouts from trees cut or girdled. Thus, in the case of crop trees again in need of treatment, it will be possible to say whether the original treatment was too light or whether the rapid sprouting of cut trees is responsible for the present crowding.

Records of cut trees are being made to get information on such points as (1) partial severance of competing vegetation versus complete severance, (2) the species hardest to kill by girdling, (3) the effect which height of cutting, species, and season of cutting have on sprouting, and (4) severity of damage to crop trees by falling of girdled trees.

The crew worked on the Monongahela Forest during the latter part of October and the month of November. There growth of spruce, white oak, and yellow poplar crop trees was studied. On each forest efforts will be concentrated on the most important species. Work on the George Washington is now under way, and white oak, white pine, and yellow poplar will receive attention there.

Cleaning. During October and November the Station's cleanings plots in sugar maple on the Monongahela, white oak and yellow poplar on the Jefferson, and yellow poplar on the Pisgah were re-measured.

Thinning plots in 45-year-old yellow poplar were given their 10-year reexamination.

Harvest Cuttings

Loblolly Pine Second-growth. Field work on the establishment of loblolly pine cutting plots was resumed in November, two blocks of six plots each being established and marked for cutting.

To date six plots have been established and marked for cutting in each of the following locations:

| <u>Block number</u> | <u>Working center</u> | <u>Location</u> |
|---------------------|----------------------------|------------------|
| I | Enoree Ranger District | Newberry, S. C. |
| II | Uharie Purchase Unit | Troy, N. C. |
| III | Duke Forest | Durham, N. C. |
| IV | Santee Experimental Forest | Wetherbee, S. C. |
| V | Johns-Manville, Inc. | Jarratt, Va. |

More than 2,300 cords of pulpwood have been marked on the cutting areas (plots and isolation areas), which total more than 200 acres. Three of the blocks will be cut during the winter and time studies made of the operations.

California

Harvest Cuttings

Regeneration: Redwood Region. An analysis of data from the Henry Creek natural reproduction quadrats is in progress to determine the approximate effect of certain factors on the establishment of redwood, Douglas fir, and white fir seedlings. The principal factors being considered are intensity of the slash disposal burn, slope, exposure, litter density, and vegetation. The area which was selectively logged in 1935, has a stand with a gross volume in excess of 40,000 board feet per acre, so it is assumed that the seed supply is adequate for all parts of the area. The quadrats have been mapped and studied by square-foot units so that the samples are reasonably uniform.

In the survey of redwood cut-over areas it was found that the density of reproduction varied with different associated vegetation groups. To check these results on a more intensive basis the number of seedlings per square foot, found in 1938, was determined for three vegetation groups which were dominant on the 328 quadrats of the Henry Creek area. The results are summarized in the following table. Only three vegetation groups are included because the other groups were not dominant on a large enough number of square feet.

Seedling incidence with respect to
three associated vegetation groups

| Vegetation Group | Total sq. ft. | Total Seedlings ^{1/} | Seedlings per sq. ft. |
|----------------------------|------------------|----------------------------------|--------------------------|
| Vine-like shrubs and ferns | 857 | 241 | .28 |
| Low herbs | 2001 | 935 | .47 |
| Tall herbs | 2210 | 1552 | .70 |
| | 5068 | 2728 | .54 |

^{1/} 92 percent redwood, remainder Douglas fir and white fir.

The results agree with the more extensive survey of redwood cut-over areas with the densest reproduction found in association with tall herbs. The principal tall herbs are tall annual and biennial herbs which invade newly burned areas but which are replaced by more permanent vegetation within a few years. The most abundant of the tall herbs on newly logged and burned areas in the northern redwood region is the Australian fire weed (Erechtites prenanthoides). This species was dominant on 1599 of the 2210 square feet on which tall herbs were dominant on the Henry Creek quadrats, but it is already decreasing in abundance and within a few years, if the area is not disturbed, will be entirely replaced by the more permanent species of the virgin redwood flora.

Central States

Stand Improvement

Sprouting Studies. The establishment of the Sprouting Study Plots (in cooperation with the Clark and Gardner National Forests) has been completed. The purpose of this study is to find out the effects of various methods of girdling of undesirable trees, at three different seasons of the year, on the subsequent sprouting of the trees involved. The first measurements on the number, size, and location of the resultant sprouts were made during the latter part of October and November. From inspection of the data, it is apparent that both treatment and time of treatment has had an effect on the sprouting of the treated trees.

The tentative results of an earlier similar study and observations on other trees indicate that the three seasons of the year used in the previous study are not going to give a complete picture of the effect the time of treatment has on the extent of subsequent sprouting. During November 2400 black jack oaks in the

vicinity of the older sprouting study plots were selected at random and marked for further treatment. One-twelfth of these trees, picked at random, are to be girdled on about the fifteenth of each calendar month. One-half of the trees selected for treatment each month are to be peel girdled (removal of bark only) and the other half are to be notch girdled (removal of bark and a portion of the sap wood). Although shorter intervals of treatment might yield additional valuable information as to the specific time when a change in sprouting occurs it is believed that information for periods shorter than one month would not be practical for field use in forest management work.

Intermountain

Harvest Cuttings

Regeneration: Ponderosa Pine. A study of the role of plant competition in natural reproduction of ponderosa pine was conducted on the cut-over portion of the Boise Basin Experimental Forest in central Idaho during the past season. A series of 192 screened spots were seeded in three vegetational types - ceanothus, ninebark, and pine grass - with companion plots bared and trenched. Two additional variables were included: shade and competition by the overwood, and exposure (northerly vs. southerly).

The average germination or "seedling percent" for all plots was 49.2 percent. The range of percentages on individual plots was from 1 to 90 percent. Germination did not vary significantly between the three types of cover, either on vegetated or on bared plots. The bared plots showed a significantly higher percentage than the vegetated plots only in the case of grass cover; the mixture of matted grass roots, litter, and soil seems to offer a poorer medium for germination than soil and litter or mineral soil alone.

Overhead shade and exposure proved to be the most important factors affecting germination. The unshaded plots showed an average of 53 percent germination as compared with 45 percent on those shaded by an overwood. Germination on south exposures averaged 58 percent, against an average of 40 percent on north exposures; this difference was consistent through all the other variations in treatment and condition. Interactions of factors were of very slight or no significance. Poorest germination was on bared plots in the ninebark type with an overhead shade on north slopes. Best was on bared unshaded plots in the ceanothus type on south slopes. It may be mentioned that the spring of 1938 was relatively cool and moist, a fact which may have produced results different in some respects from prevailing when drier or warmer conditions prevail during the germination period. The seedings will be repeated

for at least one more season to test this possibility.

Lake States

Harvest Cuttings

Marking School. A marking school for rangers, assistant rangers, and forest management officers of the Chippewa National Forest was held October 6 and 7, 1938, under the leadership of H. L. Shirley and Supervisor Knutson. Three men from the Minnesota State Forest Service were also in attendance.

Stress was laid upon the fact that maximum volume increment can be realized only by fully utilizing the growing space; this means that cuts must be light and be repeated at short intervals. Maximum monetary yield depends upon producing as many trees as possible which command a premium price. These principles applied to local stands of jack and red pine require that the cut shall come largely from trees which can be marketed for piling or mine timber, and that only 1,500 to 2,500 board feet per acre be removed in a single cutting. Good silviculture requires that consideration be taken of the trees to be removed in the next cutting, some ten years hence, before making a final decision on the tree to take now.

Mechanical Disturbance of the Forest Floor. The results of the station's experiments in mechanical disturbance of the forest floor to stimulate jack pine reproduction are now finding considerable application on the national forests of the Region. The Huron Forest has for some time been disking the ground before cutting, and during the past year the Chippewa carried on quite a program of scarification. Following this successful experience the Superior Forest undertook some administrative tests using the Chippewa disk.

The disk was tried out in a mixed stand of white pine, white spruce, jack pine, and balsam, and in a pure stand of jack pine. The work in the mixed stand was unsatisfactory because of the density of the timber and the presence of old windfalls which clogged the cutting blades. In the pure jack pine stand much better results were obtained but the coverage was rather light. The work would have been improved if less care had been used in avoiding the barking of large trees and breaking of small ones. Scarifying is an operation preparatory to clear cutting in jack pine so there is no point in using care not to injure trees. Further experience should perfect the application of the method.

Stand Improvement

In Region 9 much of the high priority coniferous stand improvement work has already been accomplished. However, during the winter months there is a large supply of available C.C.C. and WPA labor. It is the plan, therefore, to extend TSI work to second-growth hardwoods. The station has been asked to assist in setting up some administrative studies that would serve as a guide to large-scale cultural operations.

The administrative study suggested would consist of four methods replicated on each of three ranger districts: (1) A very intensive treatment in which all reasonable improvement measures would be applied. This would be in the nature of a thorough sanitation and improvement cut to benefit the whole stand without limiting the assistance to crop trees. (2) A moderate treatment in which somewhat less expensive measures would be used. This would involve limiting the work to crop trees. (3) A light and extensive type of treatment consisting of only the most obvious and inexpensive measures and the omission of such practices as pruning of crop trees which would be undertaken in the other two instances. (4) An untreated check.

Besides obtaining reliable comparative cost figures--information of immediate use--judgment could be formed as to the worth-whileness of this or that practice, and the plots would be of benefit now and in the future for visual observation without any great degree of precise measurement.

Northeastern

Silvics

Soil Fauna. Analysis of the F layer of the sample of undisturbed spruce forest litter was completed. The total population somewhat exceeded that in the L layer (being thicker) but was not as varied. Although the greater number of species were on top (at that time of day) the difference was not significant.

The small amount of work done on the H layer shows an enormous difference (lack) in total number of individuals and in total number of species. Again the question arises, "Should time be taken to study the fauna present in the H layer, when that layer is deep?"

Harvest Cuttings

A trial compilation of data on ground cover and reproduction from silvicultural sample plots has been initiated to show the wildlife value of the cover. As a sample problem the changes resulting from clear cutting of northern hardwoods on the Bartlett

Experimental Forest is being used. Studies of records of vegetation taken before and 1, 2, and 5 years later is expected to show whether the standard procedure for recording the data will yield worth-while information on food and cover values for wildlife. It will at least indicate desirable changes if the present system is inadequate. This work, should it prove successful, is preliminary to a comprehensive survey of sample plots in the region to develop forest type values for wildlife.

Northern Rocky Mountain

Harvest Cuttings

Logging Damage to Advance Reproduction Not Serious. An overwood of mature western white pine can be logged without a serious reduction of stocking in an understory of well advanced reproduction. This conclusion results from the analysis of data obtained on three quarter-acre sample plots on a Deception Creek Experimental Forest timber sale made in the summer of 1938.

The original stand consisted of an overwood of about 15 M per acre, almost all white pine, and of an even-aged 45-50 year old stand of advance reproduction averaging 1257 trees per acre, 73 percent white pine. The overwood was logged according to the usual Forest Service specifications in the western white pine type, no special precautions being taken to protect advance growth. After logging, badly damaged trees in the young stand were cut along with a few others that were removed purely as a stand improvement measure.

Trees killed in logging or cut subsequently because of injuries amounted to 20 percent of the original stand, and the stand improvement work accounted for 5 percent more. The stand was reduced to 947 trees per acre, 77 percent white pine. Felling injuries were responsible for 52 percent of the mortality, skidway construction for 47 percent, and skidding injuries for only 1 percent. In addition, 20 percent of the residual stand sustained less serious injuries, for which felling was primarily responsible. Damage to white pine was proportionately slightly less than that to other species. Damage to all species was relatively greater in the small diameter classes. The following table gives a summary of the gross effects of logging on the young stand.

Gross effects of logging, by species and diameter class,
plots 62, 63, & 64, acre-basis.

| D.B.H. | Total original stand | Cut after, or killed in log- ging | | Removed in stand improvement | Total residual stand | Residual trees injured | |
|---------------------------|----------------------------|---|----------------|------------------------------------|----------------------------|------------------------------|----------------|
| | <u>Number</u> | <u>Number</u> | <u>Percent</u> | <u>Number</u> | <u>Number</u> | <u>No.</u> | <u>Percent</u> |
| <u>Western white pine</u> | | | | | | | |
| 3 | 480 | 115 | 23.9 | 23 | 342 | 61 | 18.0 |
| 4 | 260 | 31 | 11.8 | 1 | 228 | 49 | 21.6 |
| 5 | 141 | 17 | 12.3 | | 124 | 31 | 24.7 |
| 6 | 25 | 1 | 5.3 | | 24 | 4 | 16.7 |
| 7 | 5 | | | | 5 | | |
| 8 | 1 | | | | 1 | | |
| 9 | | | | | | | |
| 10 | 1 | | | | 1 | | |
| Total | 913 | 164 | 18.6 | 24 | 725 | 145 | 20.0 |
| <u>All species</u> | | | | | | | |
| 3 | 592 | 153 | 25.9 | 31 | 407 | 69 | 17.0 |
| 4 | 364 | 51 | 13.9 | 11 | 303 | 67 | 22.0 |
| 5 | 212 | 34 | 15.6 | 12 | 167 | 47 | 28.0 |
| 6 | 53 | 5 | 10.2 | 5 | 43 | 9 | 21.9 |
| 7 | 25 | 4 | 15.8 | 3 | 19 | 7 | 35.7 |
| 8 | 7 | | | 1 | 5 | 3 | 50.0 |
| 9 | 1 | | | 1 | | | |
| 10 | 3 | | | | 3 | | |
| Total | 1257 | 247 | 19.6 | 64 | 947 | 202 | 21.3 |

The most common type of injury was loss of bark; 86 percent of the total number of injuries in the final residual stand were of this type. Top breakage accounted for the remaining 14 percent. All trees with the more serious types and combinations of injuries, notably those badly bent or knocked over, were cut. A combination of two or more types of injuries was common.

This study shows the practicability of logging a residual overwood, even where considerable volume is involved, without fear of serious damage to a well-stocked stand of advance reproduction.

Increment and Mortality on Cutover Areas. Preliminary analysis of increment and mortality information gathered on western white pine cutover areas during the past two years shows that on the areas studied growth approximately balanced mortality during the first decade following cutting while during the second decade, with decreased mortality and a slightly increased increment rate, substantial net growth was made. The situation is brought out by the following tabulation:

| Item | First decade | | Second decade | |
|--|----------------|-------------|----------------|-------------|
| | W.W. pine only | Total stand | W.W. pine only | Total stand |
| Volume per acre in board feet at time of cut or at beginning of decade | 1,507 | 6,152 | 1,604 | 5,936 |
| Volume dying during decade | 257 | 1,369 | 146 | 481 |
| Percent dying during decade | 17 | 22 | 9 | 8 |
| Volume growth on trees surviving decade | 354 | 1,153 | 424 | 1,407 |
| Percent growth | 28.3 | 24.1 | 29.1 | 25.8 |
| Net volume end of decade | 1,604 | 5,936 | 1,882 | 6,862 |
| Percent gain or loss during decade | +6.4 | -3.5 | +17.3 | +15.6 |

These data were mostly gathered on Forest Service sale areas and are believed to be fairly representative of the better cuttings in the type. They do not represent a random sample of all cuttings in the type, public and private, as areas burned over following cutting, cut over two or more times, or so thoroughly wrecked or depleted that little but a rehabilitation problem remains, were excluded from the study. The study was intended to apply to areas on which the residual stand was of some management importance.

Silvics

Methods of Determining Light Intensity Compared. Comparisons of ocular with instrumental methods of determining light intensity beneath forest canopies, made by Wellner during the past summer in mature stands of the western white pine type, have consistently shown that ocular estimates deviate less than 6 percent from percentages determined by instrumental measurements..

Previous work had already shown that crowns of trees in the western white pine type exert little filtering effect on the passage of light; that is, sun rays for the most part either penetrate the canopy unimpeded or else are almost entirely obstructed by foliage. As a result, most light measurements are either of very high or very low intensity. Utilizing this observed fact, a formula was devised as follows:

$$\begin{array}{lcl} \text{Mean light intensity beneath the canopy} & & \frac{Ay+Bx}{100} \\ \text{as a percentage of full sunlight} & = & \end{array}$$

Where:

A = percentage of individual measurements greater than 50 percent full sunlight,

B = percentage of individual measurements less than 50 percent full sunlight,

x = average intensity of reflected light (about 7 percent under unobstructed sky and approximately 3 percent under dense canopies),

and y = intensity of full sunlight (100 percent).

This formula was tested on measurements from 67 sample plots. On each of these plots, which were 4/10-acre in size and located in a wide variety of virgin and partially cut stands, 100 discontinuous measurements of light intensity had been made using a Shirley radiometer. In all tests light intensity percentage, as determined by formula, deviated less than 5 percent from the mean of instrumental measurements.

These tests indicated that any method, whether by means of inexpensive photoelectric cells or extinction meters or even ocular estimates, which is able to classify light intensities into two classes, i.e., greater than 50 percent full sunlight and less than 50 percent full sunlight, with reasonable accuracy should result in determinations sufficiently accurate for most field studies.

To determine if ocular classification would result in reasonably accurate determinations, ocular estimates were made on 17 sample plots on which measurements had been made with a Shirley radiometer. Light intensity at 100 points on each plot was ocularly classified as either "full sun" or "shade" and the mean intensity in percent of full sunlight was computed by applying these tallies to the foregoing formula. These estimated mean intensities were compared with the means determined by instrumental meas-

urements. Only one comparison showed a difference greater than 5 percent; three-fourths of the differences were less than 3 percent; and no difference was greater than 6 percent.

From these results it is concluded that for most field studies in which discontinuous measurements of light intensity beneath the canopy are adequate, ocular estimates of light intensity following the method as outlined will result in reasonably accurate determinations.

Pacific Northwest

Stand Improvement

Effect of Treatments. Some interesting developments were noted when the second annual examination was made of the stand improvement plots in old-growth stands at Wind River. The dying of girdled trees, principally hemlock, was a gradual process and some are still not completely dead two years after treatment, but the dying of trees poisoned with sodium arsenite was much more erratic. Some trees died and turned brown within six weeks, others struggled along for several months, while with still others part of the limbs turned brown and part of them remained green and showed no sign of injury. The size and vigor of crown as well as the size of bole seems to be a determining factor in the amount of poison required.

Thinning. A stand improvement cutting was made by C.C.C. boys on a 40-acre plot on the Lookout Mountain unit of the Pringle Falls Experimental Forest. This is a much overstocked, even-aged stand of 95-year-old ponderosa pine having dominant trees 18 to 30 inches at breast height and a height of 100 feet. A thinning from the top was made, the largest trees being cut, to give release to the remaining trees. The stand was evidently suffering from overcrowding. Losses from insects (D. valens) in which small groups were killed were evident and apparently on the increase but as yet not serious. The logs resulting from the cutting, containing about 120,000 board feet, were logged in November and hauled by truck and rail to one of the large mills in Bend, a distance of 41 miles. On an adjacent plot in this same even-aged stand, another treatment is to be tried in which the intermediate trees are to be removed for release. On both areas crop trees numbering about 200 to the acre will be pruned.

Harvest Cuttings

In the study of rodent influence on natural regeneration being carried jointly with the Biological Survey, first year results of comparative seed consumption showed an equal number of seedlings under screens and in the open for western red cedar, two under

screens to one in the open for Port Orford cedar and western hemlock, four to one for Sitka spruce, and five to one for Douglas fir. This study was conducted on a fresh slash burn in the spruce-hemlock type.

In 1936 the maturity selection system of ponderosa pine management, involving rather light and frequent cutting, was introduced on the Silvics Working Circle of the Malheur National Forest.

Over 40,000 acres have already been cut over by the new method on the Malheur Forest. This large cutting area affords an unusual opportunity to follow the results of the light cutting treatment on the growth and survival of the residual stand and to check them with the theoretical predictions. Therefore, early in June we began the establishment of 1/2-acre permanent sample plots throughout the cut area. After an interruption of three months the work of establishing plots was resumed and completed. There are now over 400 permanent plots in which the individual trees are tagged and some 50 miles of strips run for mortality records.

Southern

Stand Improvement

Increased board-foot growth. Board-foot volume growth on two plots at Urania, La., given improvement cuttings in 1933, and on the corresponding unimproved check plots, has been computed for the 5-year period 1933-38. Pertinent data are summarized in table 1, which shows that the rate of growth on both improved plots is better than on the corresponding check plots. The relatively great "ingrowth," especially on the improved plots, is also notable.

The plots are located in irregular, understocked stands of loblolly and shortleaf pines and mixed hardwoods. In 1933 the stands were composed of even-aged second growth about 25 to 30 years old, intermixed with large hold-over pines and hardwoods that had been left at the time of logging, some 30 years ago. The improvement cuttings removed only merchantable trees (for sawlogs and pine pulpwood), with the exception that unmerchantable hardwoods more than 9.5 inches d.b.h. were girdled. Plot I yielded 1,096 board feet, International 1/4-inch rule, and 3.4 cords of pine pulpwood per acre. This cut amounted to 33 percent of the original board-foot volume and 30 percent of the original pulpwood volume. Plot II yielded 1,217 board feet and 3.5 cords per acre, or 50 and 42 percent, respectively, of the corresponding original volume.

Plot I consists of 62 quarter-acre subplots arranged like a checker-board with alternate cut and check units. This design permits the measurement of experimental error and comparison of

results on a sound statistical basis. A detailed analysis of this kind, however, has not yet been made, and table 1 merely shows averages. Plot II consists of two 2-acre subplots and is not suitable for tests of statistical significance.

Table 1 shows net growth, but mortality alone has been negligible. On improved plot I, the average annual mortality from 1933 to 1938 has been only 3.6 board feet per acre, representing the death of a single tree (killed by Ips beetles following injuries to the stem and crown resulting from unauthorized cutting of a large girdled hardwood). To call attention to the prompt increase in the rate of board-foot growth on the improved plots, and the relatively large volume of board-foot growth in each plot despite the marked understocking, a brief article has been prepared for submission to the Southern Lumberman.

Table 1.-Stand data for the average acre, showing growth and cut in board feet
(International 1/4-inch rule) and growth in percent

| | Plot I | | | | Plot II | | | |
|---|----------|---------|------------|---------|----------|---------|------------|---------|
| | Improved | | Unimproved | | Improved | | Unimproved | |
| | Volume | Growth | Volume | Growth | Volume | Growth | Volume | Growth |
| | Bd. ft. | Percent | Bd. ft. | Percent | Bd. ft. | Percent | Bd. ft. | Percent |
| Stand more than 9.5 inches d.b.h. in 1938 | 4,754 | | 6,652 | | 4,204 | | 5,123 | |
| " " " " " 1933 | 1/3,324 | | 5,041 | | 1/2,405 | | 3,726 | |
| Total net growth in 5 years | 1,430 | 43.0 | 1,611 | 31.9 | 1,799 | 74.8 | 1,397 | 37.5 |
| Average total net growth in 1 year | 286 | 8.6 | 322 | 6.4 | 360 | 15.0 | 279 | 7.5 |
| Net growth in 5 years of pines more than 9.5 inches d.b.h. in 1933 | 919 | 27.6 | 1,146 | 22.7 | 786 | 32.7 | 772 | 20.7 |
| Average net growth in 1 year | 184 | 5.5 | 229 | 4.5 | 157 | 6.5 | 154 | 4.1 |
| Net "ingrowth" in 5 years of pines more than 9.5 inches d.b.h. in 1938, but not in 1933 | 511 | 15.4 | 465 | 9.2 | 1,013 | 42.1 | 624 | 16.8 |
| Average net "ingrowth" in 1 year | 102 | 3.1 | 93 | 1.8 | 203 | 8.4 | 125 | 3.4 |
| All pines more than 9.5 inches d.b.h. (some actually cut into pulpwood) | 1,502 | | 0 | | 971 | | 0 | |
| 1933 Cut as sawlogs | 1,000 | | 0 | | 945 | | 0 | |

1/ After improvement cutting.

Southwestern

Harvest Cutting

Cutting for Quality Increment. In present-day silviculture, any discussion of increment must consider quality as well as volume. In the Southwest, nature imposes rather rigid limitations on the size to which timber may be grown economically. Records of 25 years on two large sample plots near Flagstaff, Arizona, indicate that, because of high mortality, little net increment may be expected from ponderosa pine trees over 30 inches d.b.h. on cut-over areas. Under these conditions it is doubtful whether the gain in quality will offset the loss in volume.

In planning a second cut on a 480-acre sample plot first logged in 1909, another method of improving the quality of the remaining stand has suggested itself. The first cutting released a considerable number of small trees in the intermediate and co-dominant classes. For the most part, they have clear or practically clear boles to a height of 16 feet or more. The development of these clean-boled intermediates on old cuttings raises the question of whether they, rather than rough-boled dominants, are not the trees to which one should look for quality production. Two treatments are possible:

- (1) Leave the large trees at least another 30 years, or until they are well over 30 inches d.b.h. In the meantime they will put on a veneer of partially clear wood, but they will suppress some of the subordinate trees and retard growth of the others.
- (2) Cut the large dominants, thus liberating the smaller trees which are practically ready to start forming surface clear logs.

The experimental cutting scheduled for 1939 will provide an opportunity for comparing results under both methods.

Reproduction of Douglas Fir. In the fall of 1937 a good seed crop of both Douglas fir and white fir afforded an opportunity to make a practical test of the silvicultural and control measures required to bring about natural restocking in the Douglas fir type. Results of previous intensive studies, which sought to determine why Douglas fir cut-over stands were not restocking adequately, indicated that rodents (chiefly mice) were primarily responsible, in that they destroyed not only seed but also seedlings.

Approximately 20 acres of virgin Douglas fir-white fir timber were selectively cut in the fall of 1937, the cutting being timed so as to occur coincident with or immediately following seed

fall; the object being to obtain seed coverage through skidding of logs. To discourage rodent activity all cull material within the cutting area was removed and subsequently burned and the area was treated with poison grain just prior to and also following seed fall. This was supplemented by setting a number of large traps to catch squirrels that were cutting and storing cones.

In order to obtain quantitative data on both seed supply and seedlings, a plot of 5 acres was laid out within the larger cutting area. The number of reserved trees per acre, according to species and diameter, as based on this plot, is shown in table 1.

Table 1. Number of trees per acre reserved in a selectively cut stand of mature Douglas fir and white fir, Cloudcroft Experimental Forest.

| D.B.H. | Trees per acre | | | | |
|---------------|----------------|------------|------------|----------------|------------|
| | Species | | | | |
| | Douglas fir | White fir | White pine | Ponderosa pine | Total |
| <u>Inches</u> | <u>No.</u> | <u>No.</u> | <u>No.</u> | <u>No.</u> | <u>No.</u> |
| 21+ | 7.0 | 8.8 | 1.0 | 0.2 | 17.0 |
| 12+ | 11.4 | 23.4 | 1.8 | 0.2 | 36.8 |
| 4+ | 19.4 | 55.4 | 4.8 | 0.4 | 80.0 |

Seed fall was measured by placing one hundred 3 by 3-foot seed traps (randomly distributed) over the plot. Near each of these traps square wooden frames (5 sq. ft. each) covered with hardware cloth, were embedded in the forest floor to protect whatever seed may have fallen against destruction by both rodents and birds. The number of seedlings appearing inside these frames was recorded during the current field season. As a basis for ascertaining the number of seedlings on the area not protected against rodents and birds, an open-top frame was placed near each screened frame whenever counts were made.

Results. The following table shows the relationship between seed supply and resulting seedlings under protected and unprotected conditions.

Table 2. Number (by tree species) of seeds per acre and seedlings per acre under protected and unprotected conditions.

| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|----------------|------------------------------------|------------------------------------|-------------------------------------|--------------------------|--|--------------------------|-----------------------------------|
| Species | Actual No. seeds per acre | Viable No. seeds per acre | Seedlings per acre ^{c/} | | Relation of seedlings to viable seed | | Ratio protected Unprotected |
| | | | Pro- tected area | Unpro- tected area | Pro- tected area | Unpro- tected area | |
| | <u>No.</u> | <u>No.</u> | <u>No.</u> | <u>No.</u> | <u>Percent</u> | <u>Percent</u> | |
| Douglas fir | 152,170 | 71,824 ^{a/} | 16,988 | 4,966 | 23.7 | 6.9 | 3.4† |
| White fir | 430,712 | 109,401 ^{b/} | 12,981 | 2,526 | 11.9 | 2.3 | 5.2- |
| Total | 582,882 | 181,225 | 29,969 | 7,492 | 16.5 | 4.1 | 4.0† |

a/ Based on germination tests of 751 seeds, giving 47.2 percent germination

b/ Based on germination tests of 358 seeds, giving 25.4 percent germination

c/ Based on seedling count records as of September 10, 1938

The number of seedlings per acre, as shown in table 2, is based on actual counts of seedlings observed to be present within the sample areas on September 10, 1938. It is not known how many seedlings had died or were destroyed by rodents prior to that date.

Stand Improvement

Effect of High Pruning on Diameter Growth and Taper. In 1922, several ponderosa pine blackjacks along a road at Fort Valley were high pruned in order to hasten the melting of snow. All branches were removed to a height of 34 feet including about one-third of the living crown. In 1938, accretion borings were made on eight pruned and eight nearby unpruned trees at heights of 4.5 feet, 17 feet, and 34 feet above the ground. Diameter growth was measured on the cores, by 5-year periods, and averaged for pruned and unpruned trees separately. The results are presented in table 1.

Table 1. Diameter growth of pruned and unpruned trees at different heights by 5-year periods. Pinus ponderosa - Fort Valley, Arizona.

| Period | Height of measurement on bole | | | | | |
|--|-------------------------------|-----------|------------|-----------|------------|-----------|
| | 4 $\frac{1}{2}$ Feet | | 17 Feet | | 34 Feet | |
| | Not pruned | pruned | Not pruned | pruned | Not pruned | pruned |
| | <u>cm</u> | <u>cm</u> | <u>cm</u> | <u>cm</u> | <u>cm</u> | <u>cm</u> |
| <u>No pruning before 1922</u> | | | | | | |
| 1907-12 | 1.76 | 1.98 | 2.20 | 2.14 | 2.98 | 3.20 |
| 1912-17 | 1.40 | 1.72 | 1.92 | 2.00 | 2.64 | 2.28 |
| 1917-22 | 1.32 | 1.48 | 1.66 | 1.60 | 2.68 | 2.20 |
| <u>Trees in "pruned" columns were pruned in 1922</u> | | | | | | |
| 1922-27 | 1.28 | 1.18 | 1.58 | 1.08 | 2.20 | 2.72 |
| 1927-32 | 1.36 | .82 | 1.44 | .98 | 1.96 | 1.88 |
| 1932-37 | 1.20 | .82 | 1.24 | 1.12 | 1.78 | 1.42 |

A basis of only 16 trees is not sufficient to lead to any positive conclusions; nevertheless, the study points to a probability that severe pruning reduces growth throughout the bole for a long period. This reduction in growth is greatest at the base of the tree, with the result that there is a diminution of taper following pruning.

Pinon Experimental Plots. Cultivation, pruning and ditching of pinon trees is being tested in three experimental plots in an attempt to increase the yield of nuts. On each plot seven sets of four trees, approximately the same in size and past production of cones were treated, with treatments assigned at random, as follows: (1) pruned, (2) cultivated, (3) pruned and cultivated, and (4) control. Pruning consisted of removing the lower, unproductive branches to a height of 4 feet. Cultivation consisted of spading up and pulverizing the soil to a depth of 6 inches within a 10-foot radius of the trunk. As three growing seasons are required to produce a pinon cone, at least three years must elapse before results on the effects of these treatments become available.

FOREST PRODUCTS

FOREST PRODUCTS STATISTICS

Northern Rocky Mountain

Production - Shingles. Among the interesting statistics compiled during the canvass of the production of lumber and timber products for 1937 were the figures on shingle production. These would indicate that a small shingle industry is coming back to northern Idaho after a lapse of 20 years. In 1937 eleven small shingle mills produced 32,596 squares of red cedar shingles, or enough to reshingle more than 1,800 average homes. Most of these are consumed in the local trade territory, and this fact has resulted in a substantial curtailment of the consumption of coast shingles in the Inland Empire. The total Inland Empire production for 1937 was 37,278 squares.

Production - Christmas trees. During November, Rapraeger visited the Christmas tree producing area of northwestern Montana to obtain data on this new industry. Cutting starts about October 10, and the last trees are shipped by December 10. Except for shipments to Inland Empire cities (Spokane, etc.), almost all of the Montana trees move eastward to the upper Mississippi and tributary valleys, chiefly the Ohio and Missouri.

It is estimated that the United States consumes annually about eight or nine million Christmas trees. Of this number about one and one-half million, roughly one sixth, come from western Montana. Douglas fir is the only species utilized in quantities. It is also estimated that the Christmas tree industry in western Montana employs about 700 men for a period of two months, and that the revenue to railroads exceeds \$100,000.

Last year (1937) National Forests in Montana, chiefly the Kootenai, produced 107,000 Christmas trees, or 7 percent of the commercial cut. The average stumpage price received for these trees was 2.8 cents each. Figures for 1938 are not yet available.

PULP AND PAPER

Pacific Northwest

Species

Forms and Species of Pulpwood Used in the Douglas Fir Region. At the request of the Regional Office a survey was made of the forms and species of pulpwood used in the Douglas fir region. The results of the survey developed some interesting data.

Previous to and immediately following the World War, about 90 percent of the wood supply was purchased in log form. The effect of the 1921 depression with its resultant wage decreases and unemployment was evident in purchases of increasing quantities of cordwood so that by 1925 one-third of the requirements were in this form. Immediately following this period, and coincident with marked increases in hemlock lumber production, quantities of suitable mill waste became available. Numerous plants were established to convert this by-product into pulp chips, and in 1930 sawmill waste supplied approximately one-third of the requirements. At the same time the proportion of cordwood decreased slightly, and wood in log form decreased so much that it formed less than half the total.

During depression years when sawmill waste was greatly curtailed and pulp mills were not equipped to handle logs, cordwood again came to the fore. It was soon evident that the rapidly expanding needs of the industry could not be met from this source, and many mills established breakdown plants. An increased consumption of logs followed, so that by 1934 logs supplied 67 percent of the requirements, cordwood 23 percent, and mill waste 10 percent.

According to the estimates of the companies in the region under normal conditions, with all mills operating to capacity, the proportion of species used will approximate 76 percent hemlock, 10 percent white fir, 7 percent Sitka spruce, 6 percent Douglas fir, and 1 percent cottonwood.

TIMBER HARVESTING AND CONVERSION

California

Conversion

Analysis of logging and milling time-study data for a small portable sawmill in the second-growth pine belt of the Sierra Nevada foothills indicated that even small trees may be profitably utilized under present utilization practices. A 70-year old stand averaging about 12 M board feet per acre was cut over by this operation, trees from 12 to 30 inches being logged. Box lumber, cut to 6/4 thickness, was sold to a Sacramento box factory for \$12.50 per M, mill run.

Production costs based on contract rates averaged about \$8.40 per M, excluding stumpage and profit. Wages of the 6-man crew averaged somewhat less than \$3.00 per day. Characteristically higher costs for small trees were observed, but no actual loss was incurred by the mill owner because of the practice of contract payment. Trees of 13 inches d.b.h., however, required a total time of 1100 man-minutes per M bd.ft., compared to 750 man-minutes per M bd.ft. for 23-inch trees. With assumed wages of \$3.00 per day, 13-inch trees would cost about \$11.00 per M board feet, exclusive of stumpage and slash disposal, compared to \$7.40 for 23-inch trees.

Northern Rocky Mountain

Conversion

Logging and Milling. Office work on the field data collected last summer on the Haynes Creek experimental logging tract in the white pine type was completed during this period. A timber density map, with a horizontal scale of 200 feet per inch, and a 25-foot contour interval have been prepared to facilitate planning the engineering phases of the job. The first cut will be confined to the upper slopes of lower timber densities and poorer sites and will consist of a type of shelterwood selection designed to remove on a profitable basis the trees that are apt to die during the next 5 or 10 years from insect and other damage.

Pacific Northwest

Conversion

Pine Mill Studies - Flagstaff Study. A report on the mill and woods study conducted at the Flagstaff, Arizona, mill of Southwest Lumber Mills, Inc. is being typed in final form. This study, covering approximately 2,200 logs, was made in September 1937 by Region 4 and the Southwestern Forest and Range Experiment Station, in accordance with procedures suggested by this Station. The data have been compiled and interpreted by Lodewick and Brandstrom.

An interesting development in the analysis of sound logs was the effect of tie production on the pond marginal values of high-grade logs. Under the price and cost schedules used, there was a \$5--\$6 per M advantage when cutting ties from small Grade 1 and Grade 2 logs. This differential lessened with an increase in log size until at 29 inches the pond margins were identical. In 30-inch and larger logs the advantage was in favor of lumber production.

The large number of defective logs in the study sample, most of them with heart defect, permitted the testing of methods of calculating the influence of defect. Ratios were derived showing the relation between volume and value losses under various degrees of defect and in logs of various sizes. This opens the way for including the influence of defect in other studies where the number of defective logs has been too few to permit adequate analysis.

Time Studies. The report on the last of the six pine studies conducted during the past summer was completed. This study was especially interesting in that it was the first one made in this territory on a double-cut band. There were marked deviations from results obtained on single-cut bands, but whether these are attributable to equipment, to manufacturing procedures, or to efficiency of the mill crew cannot be determined until studies in similar mills have been made.

Reappraisals. The division has made three reappraisals of log values using lumber-grade recoveries, obtained in earlier studies, and present or more recent price schedules.

WOOD PRESERVATION

Southwestern

Durability of Juniper Posts. When the fence around a ponderosa pine plantation on the Coconino was rebuilt in 1926, posts of Utah or one-seed juniper from the Walnut Canyon vicinity were used without peeling off the bark. The entire fence was removed in 1938 because of no further need, and an examination of the juniper posts, 86 in number, was made to determine their condition after 12 years of service and, if possible, to isolate some of the factors affecting the rate of deterioration.

After 12 years of service 54 posts were still serviceable while 32 had failed. The sapwood on all of the posts was found to be in an advanced stage of decay. The heartwood of 63 posts was sound and that of the 23 remaining posts decayed to a greater or less degree. The 32 failures included the 23 posts in which the heartwood had decayed and 9 with a very small core of heartwood which had broken under impact.

The size of the heartwood core at ground level is a very important factor in determining the durability of a post. The study indicates that posts with less than 4 inches of heartwood cannot be depended upon for long-time service in the Flagstaff vicinity.

FOREST AND RANGE INFLUENCES

EFFECT OF COVER ON CLIMATE

Southwestern

Forests

Effect of oak litter on soil temperatures. That oak litter and duff have a decided insulating effect on the soil beneath is indicated by measurements of soil temperatures recorded at the Parker Creek Experiment Station in central Arizona.

Measurements are recorded by two soil thermographs in the oak-woodland type and at a depth of 3 inches. One thermometer

registers the temperature beneath an undisturbed covering of litter and duff, the other records beneath a bare surface where the covering of leaves and duff have been removed by trampling. From October to November 28, the average daily minimum temperature was 44° F. for soil at 3 inches below bare surface as compared to 49° F. for the soil at 3 inches below the litter-covered surface. For the same period, average daily maximum temperatures recorded were 62° F. for the thermometer under the bare surface and 55° F. for the one under oak litter.

Soil temperatures at 3 inches under bare ground are consistently almost 5° F. lower. This indicates that in winter bare ground will freeze harder and deeper than will ground under oak litter. In a good many instances ground under oak litter will remain unfrozen while bare ground will be frozen. Under such conditions, rainfall will be absorbed much more rapidly by the littered ground surface.

The daily range in temperature under the bare surface amounts to about 18° F. as compared to a daily range of 6° F. for the litter covered soil where temperatures are much more uniform.

The mean temperature calculated on an hourly basis for the week beginning November 14 is 44.4° F. at 3 inches under bare soil and 45.4° F. at 3 inches under oak litter.

There is a lag of several hours between air and soil temperature changes. The minimum air temperature is usually recorded between 6 and 7 a.m., while minimum temperatures under bare soil and oak litter are usually recorded between 10 and 11 a. m.

Conditions affecting germination of seeds should be more favorable in litter-covered soil than in bare soil since the former retains moisture better and temperatures are more even.

FLOOD CONTROL SURVEYS

Allegheny

Passaic River. Progress by Mesavage on the Passaic River preliminary examination justifies the expectation that the report will be ready for submission to the Field Coordinating Committee before January 1.

A number of the new infiltrometers were received and sent to the field for further testing, and working out of methods of use. Dr. Joseph Kittredge Jr., who visited the Station in November, felt that the apparatus, because of its simple design and ease of use, should be a valuable addition to infiltration equipment. The newly-designed silt sampler should be finished early in December. The Army Engineers of the Philadelphia District are not only greatly interested in this piece of equipment, but through their tidewater and siltation specialist, Mr. Wicker, have contributed valuable advice and help on the designs and construction.

Patuxent River. The Preliminary Examination Report for the Patuxent watershed was completed, approved by the Field Coordinating Committee, and sent to Washington. In line with previous policy, adopted to insure a uniform approach to the problems, the facts and proposed remedial measures developed during the examination were considered in consultation with the Army Engineers of the District concerned (Washington, D. C.) and received their approval.

Youghiogheny River. Progress on the Youghiogheny Survey is most encouraging. About three-fourths of the forest and general reconnaissance of the watershed was completed in November; and if the weather does not interfere this phase of the work should be completed by the New Year. The genuine cooperation between the members of the various bureaus, under the direction of S. S. Greene of the Soil Conservation Survey is heartening.

Up to November the system used for the forest reconnaissance consisted of observations of species, cover conditions, soil, slope, aspect, etc., made at intervals of a mile or more. An inspection of these data now shows that most of these observations fall into recognizable types, with common species, soils, and cover conditions. Checking in the field proved that these could be recognized with reasonable accuracy from roads. If field glasses were used, identifications were good up to one-half and even one mile, before the leaves fell from the trees. So far this procedure is working satisfactorily, but is frequently checked by the old method whenever changes in elevation, latitude, or other factors indicate possible modifications in the types.

In a territory, such as the Youghiogheny watershed, where fire and cutting have altered not only the species composition, but even the site conditions, it is necessary to work out modified and new type standards which are more or less local in application. In practice our types are based on factors in which the actual species play only a part, and their names are not clearly indicative of the present composition, but rather of the ecological whole and the site potentiality. For example a pure white oak type may con-

tain as little as 50 percent of white oak, and a beech-birch-maple type may be 90 percent pure beech, or 50 percent black birch, with no yellow birch present.

A formula for determining the flood control value of a given type is being worked on by Meyer and Augustine. This is based on factors of slope, soil, aspect, infiltration capacity, cover type and condition, etc. The Youghiogheny data may be supplemented. Since the data available are more or less general, highly involved computations will hardly pay, and relative rather than absolute values are expected. It is hoped the formula evolved will be simple enough to be practical.

Appalachian

Preliminary Examination. Flood control preliminary examinations made during the last year and a half on drainage areas in eastern and southeastern United States have shown that the flood problems on most drainages result from a number of related conditions rather than from any one condition. Of course, it cannot be denied that many of the so-called "super floods" are primarily the result of "super storms", but even here other factors are involved which tend to produce larger or more damaging floods.

On drainage areas and along the smaller tributaries the predominating type of problem is generally the direct or indirect result of improper land use and land management. Along the main streams improper development and other factors tending to reduce stream channel capacities are often of major importance either in themselves or in combination with the problems on the drainage area above.

Although these general problems are found on most of the drainage areas of eastern and southeastern United States and possibly in most other sections of the country, the separate problems within each of the broader classes are usually so numerous and their interrelation so different on individual drainages that each area is a distinct problem in itself, both with regard to flood problems and methods of correction.

Coosa River. The Flood Control Survey by the Department of Agriculture on the Coosa River drainage above Rome, Georgia, although delayed in getting started, is now functioning and results are being obtained.

Field work on two tributary areas, John Creek and Petit Creek, is finished and the reports are nearing completion.

California

Preliminary Examinations

Pajaro, Salinas and Santa Maria Rivers. Since May 1938, public hearings under the joint auspices of the War Department and the Department of Agriculture have been held for 10 streams and stream groups in California. Preliminary field surveys have been completed for the Pajaro, Salinas and Santa Maria Rivers.

Watershed Surveys.

Field headquarters were established in southern California. Under the leadership of the Forest Service, the following sub-watersheds have been surveyed and reports prepared for submission to the Washington Flood Control Committee:

Arroyo Seco Watershed, tributary to the Los Angeles River drainage.

Big and Little Santa Anita Watersheds, tributary to the San Gabriel River.

Mill Creek, tributary to the Santa Ana River.

Big and Little Dalton Canyons, tributary to the San Gabriel River.

San Jose Hills, tributary to San Gabriel River.

The Detailed Surveys in southern California are based upon a survey of the individual watersheds to determine erosion source areas, as a basis for planning control measures for an action program. Four major types of control work have been found to be necessary in the areas examined. These are landslide control, road erosion control, revegetation of depleted areas, minor engineering works in channels, general channel improvement in the headwaters and adequate fire protection measures.

The Surveys have indicated an interesting relation between erosion source areas and geologic formations which contribute to the instability of steep mountain slopes. In the Arroyo Seco, a 31-sq. mi. watershed tributary to the Los Angeles River, 80 percent of the land slips occurred on areas of unstable rock formation on which the vegetation had been recently destroyed by fire. Sources of erosion and estimated volume of material from each source are tabulated for the Arroyo Seco watershed:

| | |
|-----------------------------|------------------|
| Road construction, 37 miles | 300,000 cu. yds. |
| Landslides, total no. 960 | 200,000 " " |
| Burns, 1933-38, 5900 acres | 900,000 " " |

Central States

Watershed Surveys

St. Francis and Muskingum Rivers. The personnel for both the St. Francis and the Muskingum Watershed Surveys has been recruited during this period to almost full force. Good progress has been made in working out the procedure to be used for assembling factual data. In addition to collecting a large amount of data applicable to the entire watershed, both parties have practically completed the field work for the first tributary stream. Studies are now under way to determine the flood damages. As soon as these are completed, action programs may be formulated for these first tributaries.

Intermountain

Boise River. An interim report for the Boise River watershed and a detailed work plan for one of seven proposed work units has been completed.

One of the important investigational phases of the Boise Project involves the determination of the relative contribution of damaging sediment from problem areas. This is to be accomplished by means of silt sampling on sample tributaries, done on a cooperative basis by the U. S. Geological Survey.

Mr. R. L. Parshall of the Bureau of Agricultural Engineering has devised a means of reducing sedimentation damage in the irrigation canal system in Boise Valley. Preliminary laboratory tests indicate that a sand trap with curved riffles and a vortex tube may be highly effective.

Northeastern

Watershed Surveys

Buffalo Creek. Work on the Buffalo Creek watershed including Buffalo, Cayuga, and Cazenovia Creeks was begun on August 8 under the supervision of Dr. Miles H. Cubbon, of the Soil Conservation Service. Up to November 1 the following major items have been accomplished.

1. Five representative sample areas have been intensively mapped for cover, soil, slope, and erosion, and land use planning has been completed for flood and erosion control. One minor watershed has been completely mapped for cover.

2. Stream bank reconnaissance has been largely completed on a 20 percent basis to determine sources of silting, measures needed for protection and damage losses to landowners.
3. Aerial photo maps have been traced to facilitate work on an extensive cover map, which also includes soil, slope, and erosion.
4. Forest lands within sample areas have been classified according to their present condition and value as water retardants in the land use picture.
5. Studies of the existing forest plantations have been made to determine the limiting factors involved in large-scale reforestation for run-off retardation and erosion control.

In addition, statistical data on land use and ownership, climatic records, AAA records, tax delinquency, and other pertinent information have been gathered.

Pacific Northwest

Preliminary Examination

Lowell Creek. The preliminary examination flood control report for the Lowell Creek watershed in Alaska was completed and submitted to Washington late in November.

Early in October the Washington office sent out a list of watersheds to be given preference in the preparation of flood control reports and this necessitated some changes in our priority list.

INFLUENCE OF NATURAL VEGETATION ON STREAMFLOW

Appalachian

Forest

Maximum Storm at the Coweeta Experimental Forest. A storm producing the maximum recorded run-off from the Coweeta Experimental Forest, Macon County, North Carolina, occurred November 4 and 5,

1938. Precipitation over the area of approximately 6 square miles was measured in 65 U. S. Weather Bureau standard gages and six recording gages. The distribution of the storm and the resulting peak discharges for the two major tributaries of the experimental forest are shown in the following table:

Storm of November 4 and 5 - Coweeta

| Tributary | Drainage area | Rainfall | | | | Run-off | |
|---------------------------|---------------|--------------|-----------------------------|-------------------|---|----------------|---------------|
| | | Duration | Std. gages Weighted mean | Max. for one hour | No. hours exceeding 0.5 inches per hour | Peak discharge | |
| | <u>Sq.mi.</u> | <u>Hours</u> | <u>Inches</u> | <u>Inches</u> | | <u>C.f.s.</u> | <u>C.s.m.</u> |
| Ball Creek (Area No.9) | 2.794 | 12.7 | 5.80 | 2.46 | 7 | 247 | 88.4 |
| Shope Fork (Area No.8) | 2.932 | 12.7 | 4.90 | 0.91 | 4 | 139 | 47.4 |

On these relatively small drainages the duration of the storm was the same, but the weighted mean precipitation on area 9 was 0.9 inch (or about 18 percent) greater than on area 8. The storm centered on area 9 in a strip paralleling the stream. The maximum and minimum precipitation for this area was 6.70 inches and 3.28 inches, respectively. On area 8 precipitation varied from 6.42 to 2.95 inches with the larger amounts covering only a small percentage of the drainage area near the lower reaches of the stream. The differences in rainfall rates on the two areas are of more significance than the differences in the total rainfall. The maximum hourly rate on area 9 was over two and one-half times as great as on area 8. A rainfall rate in excess of 0.5 inch per hour occurred during seven hours on area 9 as compared to four hours on area 8.

These differences in rainfall on the two drainages are definitely reflected in the peak discharges which from area 9, on a unit area basis, was 1.87 times that from area 8. This figure is consistent with the comparable tributaries of the two major drainage areas most of which show peak discharges as well as unit discharges within area 9 approximately twice those within area 8. During a previous four-year period the maximum peak discharge from area 9 was 67.6 cubic feet per second per square mile, which is 20.8 c.s.m. less than the peak of November 5. This storm established new peak discharges on most of the tributaries of Ball Creek but on only two of Shope Fork. The capacity of the weir blade was exceeded on three streams, but the depths of water over the concrete control sections were too small to permit current meter measurements of velocity. The greatest discharge in excess of the blade capacity as computed by using the Manning formula was

only 11 percent of the total peak discharge. For this reason, errors in selecting the proper value of "n" (the coefficient of roughness) in the formula would have little effect on the accuracy of the total discharge determination.

Data obtained during this storm, along with measurements of stream discharges produced by it, are valuable for analyzing the influence of forests on stream behavior. These data also show the necessity for closely spaced rain gages and an equally intensive stream gaging program to analyze the factors involved in the rainfall-run-off equation.

California

Chaparral

San Dimas Experimental Forest. Activities on the San Dimas Forest during the past several months have centered on the rehabilitation of research installations and physical improvements damaged by the flood of March. Even with special funds for this work and the sacrifice of research, it has been impossible to restore facilities as they existed prior to the storm, especially roads and trails. The system of rain gages, the 17 stream gaging stations, with the exception of No. 1 at the mouth of Wolfskill watershed, and the 7 debris reservoirs are now in working order.

More recently another misfortune took place when a fire, caused by the blowing down of a high-tension power line by a heavy wind, swept up from San Antonio Canyon during the early morning of November 18 and burned into the San Dimas drainage. Approximately 500 acres of the oldest and heaviest vegetation, including the Fern small watersheds and a series of nine 1/40-acre run-off and erosion plots, were destroyed. This area had not been burned over in at least 50 years and included some of the best oak-chaparral cover in this region. High wind and low humidity resulted in a fast-moving and intense but spotty fire. South-facing chaparral-covered slopes within the burned area were swept clean, whereas the oak cover on north slopes escaped complete destruction in spots where the fire did not crown, but consumed all litter and ground cover.

A preliminary estimate of losses of Experimental Forest equipment totals approximately \$30,000, including a new 100-man camp, two climatic stations, recording apparatus at plots, a shelter cabin and other equipment. Damages that will result to roads, trails, and tractor-reconditioned fire-breaks now exposed to excessive erosion in the winter storms, which are immediately to be expected, is estimated to be at least an additional \$5,000.

At this time every effort is being made to replace the research equipment destroyed by the fire and to increase the capacity of the gaging stations at Fern watersheds 1, 2, and 3 so that expected debris flows from these denuded areas may be measured during the approaching winter season. The fact that three to four years' records of precipitation, run-off, and erosion have been obtained from these watersheds and plots with vegetation undisturbed will make the data obtained from them in their present denuded condition of primary significance.

Central States

Artificial Rain-Maker and Run-off. Most investigators agree that grass and forest lands do not suffer as much from run-off and erosion as do cultivated fields. When it becomes necessary, however, to evaluate a flood situation on a watershed where forests are present in all stages of decadence from fire, grazing and abuse, and where meadow and pasture, and cultivated fields are found in various conditions of use on different soils, the problem of relative evaluation necessitates exact data.

Permanent watersheds provided with weirs and settling basins are costly and require time for installation and operation. Some more flexible method capable of measuring run-off and erosion under varying cover conditions is much desired. In order to fill this need a portable sprinkling outfit was constructed for use in the St. Francis Basin of the Ozarks region of Southeastern Missouri. Briefly the outfit is a rectangular canvas-enclosed frame 11 x 20 feet, 14 feet high, open at the top. Nozzles are spaced inside the frame and so set as to deliver rain-sized drops at the rate of four inches of water per hour. The water which runs off a 6 x 15 foot plot inside the enclosure is measured for volume and silt content.

In the development of the sprinkling outfit it became necessary to design and develop a nozzle. Auten, assisted by Marshall, designed and calibrated a brass nozzle which delivers each fifteen-minute period through a .015-inch slit at twelve pounds pressure a volume of drops equivalent to one inch of rain.

Southwestern

Precipitation gages installed on Workman Creek Watershed. Five new shielded storage precipitation gages were installed on the Workman Creek Watershed on November 28 by Weather Bureau men--- Ashton R. Codd of Salt Lake City and G. K. Greening of Phoenix -- and Parker Creek personnel. Although not used heretofore in Arizona, these gages have proved satisfactory in snow measurement in

the high-mountain area of New Mexico and elsewhere in the Rocky Mountain region.

Each gage consists of a can the size of the standard Weather Bureau gage placed in a steel tower about 7 feet in height. It is shielded from wind currents by a ring composed of flat strips of light weight galvanized iron. A solution of calcium chloride strong enough to prevent freezing of first 4 or 5 inches of precipitation is dumped into each gage and a small amount of machine oil added to prevent evaporation. Cans are then weighed. The accumulation of snow or rain water is measured by reweighing the cans after each storm.

The five individual gages are located approximately 300 feet apart, being situated in rectangular form with one at each corner and the fifth in the center.

STABILIZATION OF SOILS

California

Watersheds

Measurements were made of debris deposited during the season of 1937-38 in the Bell and Fern reservoirs and in the Big Dalton and San Dimas flood control reservoirs. Complete records of erosion were obtained from Bell No. 4 and Fern No. 3 watersheds. The other small reservoirs overflowed with debris. Most of this material was deposited during the storm of March, 1938.

| Reservoir | Watershed Area | Volume of Eroded Material | Cu.yds/sq.mile |
|------------|----------------|------------------------------|----------------|
| Big Dalton | 4.47 sq. mi. | 65.8 ac. ft. | 23,748 |
| Bell No. 4 | 0.058 " " | 1095 cu. yds. | 18,887 |
| Fern No. 3 | 0.084 " " | 161 " " | 1,917 |

Field surveys completed recently include a geologic map of the Big Dalton drainage and detailed vegetative type map of the Fern Small Watersheds.

Intermountain

Watershed

Boise Erosion Project. Contour drilling of a mixture of winter rye and perennial grasses at vertical intervals of less than 10 feet is highly effective for controlling erosion on depleted range lands according to a preliminary inspection of data derived from one of several experiments at the Arrowrock sub-station during the past season. Two sizes of paired plots (6.6 by 33 and 6.6 by 16.5 ft.) with and without a contour drill row across the lower end, were subjected to high intensity artificial rainfall in this study.

The Richards tensiometer promises to provide a simple method for following the recession of the water table and the consumptive use of water by range vegetation during the growing season. A battery of these instruments performed satisfactorily during the past season in a preliminary installation.

Analysis of precipitation records accumulated during the past winter show that the "snow board" designed by this station accurately measures winter precipitation even under conditions of high wind and excessive drifting. However, the daily attention required and the resulting trampling point to the need for a gage of similar design which will operate automatically for long periods. An improved instrument has been designed.

Cooperative Erosion and Flood Control. Cooperation with Region 4 in planning flood and erosion control work on problem areas on the national forests has been a major activity.

A Station representative has met with supervisors or rangers in the field and a preliminary plan for each project has been formulated involving (1) nature of the problems on the area, (2) objectives of rehabilitation, and (3) methods.

Rehabilitation of problem areas has been started for parts of five C.C.C. camps, on seven work areas on the Cache, LaSal, and Manti National Forests.

The Measurement of Accelerated Erosion on Range-Watershed Lands. An intensive study involving the measurement of accelerated erosion has just been completed and this shows the following:

(1) Summary and Conclusions. A soil erosion survey was made of three adjacent range watersheds near Salt Lake City, Utah: Emigration, Red Butte, and City Creek. The purpose of the study was to measure the qualitative and quantitative soil changes produced by erosion and to determine the relationship of these

changes to the intensity of grazing use to which each drainage has been subjected. During the last 40 years City Creek has had only slight grazing use, Red Butte, moderate use, and Emigration has had unregulated heavy use.

A close relation was found between intensity of use and accelerated erosion. Only 13 percent of the sites in Emigration Canyon were in an undisturbed condition while 20 and 36 percent of the sites in the Red Butte and City Creek drainages, respectively, showed no disturbance. The present average soil organic matter content of the City Creek Canyon soils was 65 percent of that found in its undisturbed soil, while Red Butte and Emigration Canyon soils showed an average of 56 and 49 percent as much organic matter as that found in their undisturbed soils. Soils from heavily eroded areas showed an average loss of 70 percent of organic matter and moisture equivalent values were reduced 40 percent as compared with undisturbed soils.

Accelerated erosion is confined almost exclusively to south aspects.

(2) Results. The basis for judging soil changes or losses is to compare present average surface conditions in any drainage as determined by an average of the analyses of systematic samples with the uneroded condition in the same drainage as determined by an average of the analyses of samples from all uneroded sites (class samples). ^{1/} The ratio of these two values is referred to as percent "normal", ^{1/} with respect to the organic matter content of the surface inch. The results are summarized in table 1.

^{1/} "Normal" as used herein, refers to stable uneroded soil. It is not inferred that the soil of any drainage was all in this condition at any one time. It is, however, a desirable ideal that could probably be approached under absolute protection from fires, and grazing of all kinds, but which actually may never become higher than 80 percent. The condition termed "normal", therefore, is used only as a standard to which the average present soil condition may be compared.

Table 1.- The frequency and organic matter content of each erosion class, mean organic matter content (in percent), and percent normal of each drainage.

| Drainage | Class of Accelerated Erosion | | | Mean Organic | Percent### Normal |
|------------|------------------------------|-------------------|-------------------|----------------|----------------------|
| | None | Moderate | Heavy | Matter Content | |
| | Frequency | Frequency | Frequency | Analyzed# | |
| | Organic Matter | Organic Matter | Organic Matter | Calculated## | |
| Emigration | <u>13.0</u> | <u>42.7</u> | <u>44.3</u> | <u>7.5</u> | 49 |
| | 15.2 | 9.2 | 4.3 | 7.8 | |
| Red Butte | <u>20.4</u> | <u>56.7</u> | <u>22.9</u> | <u>6.8</u> | 56 |
| | 12.1 | 6.5 | 3.2 | 6.9 | |
| City Creek | <u>35.8</u> | <u>42.5</u> | <u>21.7</u> | <u>9.2</u> | 65 |
| | 14.2 | 8.1 | 5.0 | 9.6 | |

From analysis of systematic samples

Calculated as sum of frequency times organic matter for each class:

$$(13.0 \times 15.2) + (42.7 \times 9.2) + (44.3 \times 4.3) = 7.8$$

100

$$### \text{Percent normal} = \frac{\text{mean organic matter}}{\text{organic matter in uneroded}} \times 100. \left(\frac{7.5 \times 100}{15.2} \right) = 49$$

° Significant difference

°° Highly significant difference

The accuracy of the method depends largely on whether or not erosion on any given area can be classified consistently by ocular means using established criteria for classes used. The existence of one set of samples taken at measured intervals (systematic samples) and a second group collected and classified on the basis of degree of erosion (class samples) made a check possible. Laboratory analysis of all systematic samples from any watershed provided a way of measuring average soil organic matter content, for example, for that watershed. This value, arrived at by analysis of a large number of samples would be fairly representative of actual soil organic matter content, but it does not indicate that samples were classified consistently.

A second method of measuring average organic matter content, as shown in table 1, consists of using the frequency of each erosion class as shown by the systematic samples and the organic matter content of each erosion class as determined by laboratory analysis of the erosion class samples. The results of the two methods are very close.

A comparison of accelerated erosion at different elevations, as represented by the three transects, indicates a marked increase in organic matter content with elevation (table 2). The difference

in loss as indicated by percent normal is not significant based on analysis of variance.

Table 2. - A summary of surface inch soil conditions at different elevations.

| Transect altitude | Percent organic matter of un-eroded soil | Average percent O.M. systematic soil samples | Percent normal |
|-------------------|--|--|----------------|
| 5,350 feet | 10.9 | 5.2 | 48 |
| 5,600 feet | 12.9 | 7.7 | 60 |
| 6,800 feet | 17.6 | 10.5 | 60 |

Accelerated soil erosion on the north aspects (table 3) is practically the same. There is a striking and highly significant difference between the north and south aspects of all drainages except City Creek where soil conditions on both aspects are practically the same. Apparently past soil changes are confined almost exclusively to south aspects.

Table 3. - Comparative soil conditions, expressed in percent normal, based on the organic matter content of the surface inch of soil on north and south aspects.

| Watershed | North Aspect | South Aspect | |
|------------|--------------|--------------|----|
| Emigration | 62 | 38 | oo |
| Red Butte | 61 | 51 | oo |
| City Creek | 65 | 64 | |
| Average | 63 | 51 | oo |

oo Highly significant difference between aspects.

Several factors are important: Plant cover is more dense on north than on south aspects, north aspects are less accessible to livestock and game than are south aspects; grazing animals have a tendency to congregate on the warmer south aspects during colder seasons; plant growth occurs earlier in the spring on south aspects causing longer period of use by grazing animals each year; on south aspects where the organic "A" horizon may be thinner or where the protective plant and litter cover may be less than on opposite north aspects, accelerated erosion may be more easily induced.

(3) Discussion. Soils on these steep range watersheds could probably not have developed without the protecting influence of vegetative cover. This is obvious because of the ease and rapidity with which soil is altered or lost when plant cover is materially reduced or destroyed.

Considering the slow rate at which soil is formed, especially on steep slopes of the drainages studied where the natural erosion potential is high, it may be regarded that the soil losses resulting from moderately accelerated erosion during the 90 years since settlement of the adjacent valleys, are equal to the developmental gains of a few centuries and that losses incident to seriously accelerated erosion are probably equal to the developmental gains of many centuries. While the loss that occurs in the life span of the average individual may seem relatively small, it is extremely great when compared to the time required for soil formation. In a few years of over-utilization, often more soil has been destroyed than can be formed by nature in many centuries.

Because stable soil is the basic asset of range watersheds on which the production of most of the usable resources is more or less dependent, the seriousness of even slow but constant soil deterioration may be expected to produce profound economic and social disturbances in adjacent dependent communities.

RANGE RESEARCH

ARTIFICIAL REVEGETATION

Intermountain

Species

Artificial Reseeding Succeeds on Abandoned Dry-farms. Recent tests on abandoned dry-farms in southeastern Idaho have shown that reseeded can be attempted on such areas with reasonable assurance of success. In species trials seeded in the spring and fall of 1937 and 1938, seeds of 10 species of grasses were sown broadcast on 1/100-acre plots in randomized blocks. The seed was covered by use of garden rakes and hand cultivators.

Crested wheatgrass (Agropyron cristatum), which produced seed the first year, is the most promising. Other species making favorable showings are slender wheatgrass (A. pauciflorum), west-

ern wheatgrass (A. smithii), beardless wheatgrass (A. inerme), blue-bunch wheatgrass (A. spicatum), and in some instances tall meadow oatgrass (Arrhenatherum elatius).

Methods

Research Guides Extensive Seeding in Region 4. Results from more than 3,000 artificial reseeding plots established throughout the Intermountain Region during the past 3 years have enabled the experiment station to be of material assistance in planning and supervising a number of large scale plantings on 11 national forests this fall. Approximately 5,000 acres, on ranges varying from dry depleted foothills to high alpine meadows have been seeded by Region 4.

Four perennial grass species were used, usually in mixtures with winter rye as a nurse crop on some areas. On the lower dryer sites, Poa bulbosa supplemented by Agropyron cristatum was recommended. At intermediate zones, Agropyron cristatum and Agropyron pauciflorum were the principal species while on the mesophytic areas Agropyron pauciflorum and Bromus inermis were used.

Every effort was made to cover the seed since this is usually a prerequisite to success. Drilling, and broadcasting followed by harrowing, disking, dragging, or trampling by sheep were among the methods of planting. The outlook for success at the present time is good. Early fall precipitation has resulted in germination of most of the species, but lower than normal temperatures have allowed but little growth to date.

Northern Rocky Mountain

Species

Fall plantings were made at Missoula, Vigilante, and Miles City nurseries with 77, 65, and 44 species, respectively. Many of the areas seeded previously--especially the crested wheatgrass--made a very good showing during the relatively favorable spring weather. Crested wheatgrass seed is relatively plentiful this fall with prices ranging from about 15 to 30 cents per pound.

Southwestern

Methods

Water Conservation and Reseeding. In order to test various methods of water conservation and to determine if it is possible to establish a stand of the more valuable perennial forage grasses

such as black grama by reseeding, a fence was constructed in August 1937 to enclose 10 acres in Pasture 6 on the Jornada. Inside this fence which included the original Dona Ana enclosure, established in 1915, small crescent shaped dams with a level basin were constructed merely by raking the topsoil in a semi-circle where run-off water might collect. Contour furrows were plowed at intervals of 10 to 20 feet and plugged occasionally to prevent extensive washouts. Oat sacks were filled with soil and placed at intervals of 15 feet in several of the small gullies on the slope. Several shovels of manure were placed in some of the sacks. Check dams were constructed by stretching cotton mesh fabric across gullies and filling the uphill side with soil.

All these structures, including crescents, check dams, furrows and gullies, were broadcast seeded at the rate of about 8 pounds of seed per acre with a mixture of seeds which was composed mostly of black grama but included tobosa, side-oats grama, 3 species of dropseed, 2 annual grasses, and 1 shrub, chamiza.

Heavy rains in September 1937 and the summer of 1938 greatly damaged the furrows and check dams, but even as early as October 2, 1937, many thrifty young plants of chamiza, black, side-oats and blue grama, and dropseed grasses appeared in the crescents, furrows, and sacks. These became well established and made excellent growth during the 1938 growing season, and a former shrub and weed type has already been converted to one supporting about 30 percent of perennial grasses. In June, 1938, a small area about 1 acre in extent was fenced rabbit proof as a means of determining rodent influence.

Preliminary results of this experiment demonstrate the possibility of successful reseeding of ranges by even the more valuable grama forage plants under a combination of favorable climatic conditions and some artificial treatment. Of course, where low land values are involved such a method would be impracticable for general application, but certain key or strip areas could be so treated with the idea of the entire area improving in time by natural revegetation.

GRAZING MANAGEMENT

California

Utilization Standards

Through Station-Region effort, non-technical tentative range utilization standards were prepared and released for checking through the summer. These have now been recalled and revision is well under way.

A search of the Station and Region files in the spring of 1937 revealed that there was little specific technical information available for use in developing range utilization standards for a large number of types. This made it necessary to work closely with the field force in developing the technique of range evaluation. During the 1937 and '38 field seasons the several forage types were visited and the significance of soil and plant conditions discussed on the ground with various men charged with range administration. In addition to this, two other and important meetings were held. In the fall of 1937 a group of Station, Region, and Forest Range men held a planned trip through various forage types. Previously selected areas representing a particular condition would be discussed by the group. After agreement, photographs and descriptions would be made for the standards. This fall at the Feather River Training Camp a group of 17 Rangers spent a week on a critical review of the tentative material, submitting specific recommendations and urging that the standards soon be made available to them in final form.

Particular attention has been given to the importance of maintaining the soil surface. Likewise, it has been emphasized that for most open forage types in the mountains a scattering of perennial herbaceous material in the openings between the shrubs and trees is a sign of satisfactory range and soil conditions.

Intermountain

Summer Ranges

Excessive Utilization Lessens Plant Vigor. At the close of the 1937 grazing season on the Manti National Forest individual plants of slender wheatgrass, mountain brome, and hairy geranium having varying degrees of utilization were staked for observation the following year.

Four series of 20 plants each were established for slender wheatgrass and mountain brome, and three series for hairy geranium based on an estimated degree of use.

During 1938 weekly observations and measurements were made of these plants from date of "snow-off" until the plants were fully mature and ceased to make further growth. Snow-off occurred for the mountain brome plants about May 18, for the geranium series about May 20, and for the slender wheatgrass about May 24. Both grasses had already begun growth at date of snow-off, and the geranium plants were noted to be growing within one or two days after the snow had left.

No differences were noted in any series in inception of spring growth. However, by June 6, when first measurements were recorded it was clearly shown that plants of each species fully used in 1937 had made considerably less growth than those used lightly or not at all. This deficit in plant growth was not overcome as the season advanced.

Table 1 gives a summary of the average height measurements by weekly intervals during the season. Values are presented in percentages, using the height of the ungrazed series as the base for each week's value.

| Table 1.- Height growth on stated dates in 1938 of slender wheatgrass, mountain brome, and hairy geranium on plants variously utilized during 1937. | | | | | | | | |
|---|--------------------|--------|--------|-------|---|--------|--------|-------|
| Date | Slender Wheatgrass | | | | Mountain Brome | | | |
| | Series | | | | Series | | | |
| | I | II | III | IV | I | II | III | IV |
| Percent Utilization Fall 1937 | 100% | 70-80% | 35-50% | 0% | 100% | 70-80% | 35-50% | 0% |
| June 6 | 60.8 | 70.2 | 64.6 | 100.0 | 82.1 | 76.3 | 88.6 | 100.0 |
| 13 | 66.3 | 81.6 | 78.9 | 100.0 | 74.1 | 73.6 | 89.9 | 100.0 |
| 20 | 70.8 | 87.9 | 79.6 | 100.0 | 72.9 | 74.6 | 85.5 | 100.0 |
| 27 | 73.9 | 95.2 | 91.2 | 100.0 | 75.9 | 74.8 | 92.8 | 100.0 |
| July 5 | 79.4 | 91.1 | 95.6 | 100.0 | 67.0 | 71.6 | 80.8 | 100.0 |
| 11 | 69.4 | 85.6 | 91.9 | 100.0 | 75.2 | 78.7 | 89.5 | 100.0 |
| 18 | 69.8 | 87.3 | 92.6 | 100.0 | All series were grazed heavily after July 11. | | | |
| 25 | 65.1 | 84.1 | 94.1 | 100.0 | | | | |
| Aug. 1 | 63.9 | 79.6 | 94.1 | 100.0 | | | | |
| 8 | 65.1 | 83.6 | 98.7 | 100.0 | | | | |
| Av. | 68.4 | 84.6 | 88.4 | 100.0 | 74.5 | 74.9 | 87.8 | 100.0 |

Hairy Geranium

| | Leaves | | | Flower Stalks | | |
|-------------------------------|--------|--------|-------|---------------|--------|-------|
| | Series | | | Series | | |
| | I | II | III | I | II | III |
| Percent Utilization Fall 1937 | 100% | 35-50% | 0% | 100% | 35-50% | 0% |
| June 6 | 87.1 | 106.4 | 100.0 | | | |
| 13 | 63.5 | 95.0 | 100.0 | 54.6 | 103.9 | 100.0 |
| 20 | 84.0 | 93.4 | 100.0 | 79.7 | 111.0 | 100.0 |
| 27 | 80.4 | 96.8 | 100.0 | 96.4 | 107.1 | 100.0 |
| July 5 | 74.6 | 81.7 | 100.0 | 91.7 | 100.5 | 100.0 |
| 11 | 78.5 | 82.9 | 100.0 | 87.9 | 93.4 | 100.0 |
| 18 | 80.8 | 82.2 | 100.0 | 82.6 | 84.7 | 100.0 |
| 25 | 78.1 | 82.1 | 100.0 | 81.9 | 83.9 | 100.0 |
| Aug. 1 | 75.3 | 80.6 | 100.0 | 84.3 | 85.0 | 100.0 |
| 8 | | | | 84.1 | 84.8 | 100.0 |
| Av. | 78.0 | 89.0 | 100.0 | 82.6 | 94.9 | 100.0 |

Wheatgrass plants that had been grazed to ground level the previous year produced only 63 percent as much growth as plants which were ungrazed in 1937, while plants which were utilized about 70 to 80 percent and 35 to 50 percent made an average growth of 85 and 88 percent respectively of that made by ungrazed plants. Mountain brome plants fully utilized and those utilized to about 70 to 80 percent yielded only about 75 percent as much forage as ungrazed plants, while those used between 35 and 50 percent in 1937 produced about 88 percent as much as ungrazed plants. The 70 to 80 percent use for mountain brome had a more deleterious effect upon forage production the following year than did the same degree of use upon slender wheatgrass. Full utilization of wheatgrass plants for one year very markedly reduced the vigor of these plants the next season.

Grazing use of hairy geranium in one season seemed also to cause a less forage yield the following season, as compared to unused. Complete utilization caused about the same reduction in yield over 35 to 50 percent use (regarded as about proper use on this range), as this latter degree of use reduced the yield over that of ungrazed plants. Moderate grazing use seemed to stimulate earlier production of flower stalks.

Winter Ranges

Forage Volume Indexes and Proper-Use Factors. In order to compensate partly for the inequalities in the volume of forage produced by the various plant species, a volume index has been developed for preliminary use on the winter ranges of the Inter-mountain region. The major plant species have been assigned a

rating according to the weight of current plant growth produced on a common unit of density. Ricegrass (Oryzopsis hymenoides), because of its abundance and widespread distribution, was assigned weight-volume of unity (1.0). Sand dropseed (Sporobolus cryptandrus) produces only 0.7 as many grams of forage per unit of density as does ricegrass and blue grama produces only 0.2. A number of the less important plants were estimated and assigned ratings based on species which have a similar growth habit and for which data on weight-volume were available. The relative weight per unit of density for a given species varied considerably between localities, in many cases exceeding 300 percent. In all cases, the rating assigned is the mean based on a large number of observations.

From actual use records and from a large number of detailed individual observations on sheep and cattle, mean proper-use factors were developed for desert plants. It varied considerably with season, type composition, and the choice of the various bands of sheep.

There are a few outstanding differences in the proper-use ratings between the desert and other localities. For example, grama grass which is rated on summer range in Region 4, and in the Southwest and Montana on year-long ranges, as being excellent forage and being readily taken by all classes of livestock, has been found on the desert when dry to be almost untouched by sheep, and to be eaten only moderately by cattle. When the grama grass happens to be green, it is highly palatable to sheep.

Bottlebrush squirreltail (Sitanion hystrix) which tends to remain green at the base is also very highly relished by sheep and cattle during the winter. In general, all weeds are usually more readily taken and utilized to a greater degree during the winter grazing season than they are at other periods of the year. Lepidium sconulorum, Sphaeralcea grossulariaefolia, S. caespitosa, Enceliopsis nudicaulis, E. argophylla, and many others are highly relished.

Some of the major forage species have the following ratings:

| | Relative Volume | Proper-Use Factor | |
|-----------------|--------------------|-------------------|--------|
| | | Sheep | Cattle |
| Black sagebrush | 0.5 | 75 | 10 |
| Winterfat | 0.6 | 60 | 60 |
| Ricegrass | 1.0 | 75 | 75 |
| Gallota grass | 0.4 | 35 | 65 |
| Shadscale | 0.8 | 35 | 10 |
| Globemallow | 1.0 | 80 | 40 |
| Blue grama | 0.2 | 10 | 50 |
| Sand dropseed | 0.7 | 15 | 30 |

Handling Livestock

An economic analysis of the early lambing operation of farm-flock ewes shows that this type of early market lamb production has a potential future relationship to national forest range management in the intermountain region. Farm-flock sheep production has recently been expanding in the irrigated districts of Utah and Idaho, and recent census data indicate that farm-flock sheep now account for 11 percent and 7 percent, respectively, of the sheep numbers of these two states.

The production of early market lambs is a recent adaptation of the farm-flock enterprise, although practiced for a number of years on one of the Utah irrigation projects. These sheep are run on the farms the entire year. The ewes are bred in July and August, and the lambs are dropped in December and January. Milk-fat lambs are sold in April and May. This operation requires full feeding of alfalfa hay and grain for 4 or 5 months. The lamb crop marketed is 100 to 125 percent and 80 to 110 pounds of lamb for each ewe bred. This lamb production is approximately 50 percent greater than that of the farm flocks using national forest summer range and selling their lambs off the range in the late summer and fall.

The probable farm family labor income from a farm flock of 200 ewes is \$700 to \$800 for the early lambing operation compared with \$350 to \$450 for the late lambing. The probable operator labor income for the range band of 1,000 ewes is \$1,000 to \$1,200.

A budgetary comparison of the probable income from the use of farm labor, feed, and pasture indicates that early market lamb production by the farm flock can compete with dairy production. Farm pasture during the spring and summer is the limiting factor for the farm flock enterprise on the irrigated farms. A study of the results of irrigated farm pastures indicates that farm-flock sheep pasturage can be produced at a cost of 10 to 15 cents a sheep-month for a 6-months pasture period. A compilation of lease price data on privately-owned range lands in the intermountain states shows an average cost of 11 cents a sheep-month during the past 10 years.

Northern Rocky Mountain

Shortgrass Ranges

Substantial recovery of drought stricken ranges has occurred in eastern Montana during the past season, largely in the form of abnormal height growth of the surviving vegetation. Very favorable moisture conditions in the fall of 1937 and again in the spring of 1938 are largely responsible for unusual height growth this year.

Overly optimistic reports of "best range conditions in years" are based largely on casual observations of this abnormal height growth coupled with livestock far below the normal numbers, rather than any large increase in density or to new grass seedlings. It may require a long time yet to restore the density of grama grass, even though little bluegrass has greatly increased to the point where it is the predominant grass over great areas. It furnishes little feed, however, except for limited periods in spring and sometimes in the fall. In contrast, the forage of the experimental cattle pastures furnished about 70 to 75 percent of the animal months feed prior to the 1934 drought. This indicates that the effects of the drought are still very evident. More detailed quadrat and other data emphasize this and indicate the need for conservative policy in restocking of these drought-stricken ranges.

Experimental sheep pastures, stocked on the basis of forage present near the low point of the drought, carried 42 ewes each for the normal season March 16 to November 23. There was little fall growth of forage as compared to 1937 and very slight carry-over of forage in smaller pastures slated for overgrazing. Only 4 sheep were killed by coyotes after July as compared to 25 head prior to that date when an electric fence charger was hooked up to the outside boundary. It is hoped that the electric fence will reduce losses very materially. The cost of keeping grass cut to avoid shorting the charge makes these fences rather expensive.

Pacific Northwest

Utilization Standards

During the past year a new method of estimating percentage utilization of a key species has been proposed, that of determining the residual or stubble height of a grass species key to the use of the entire type and of determining the percent use of the species by a "utilization" or "volume" table prepared for that species. The distribution of weight of forage produced by a given species is more or less constant at given height intervals above the root crown. Another method of estimating use is the ocular-by-plot method, wherein percent use of all plants of a given species on a relatively small plot is estimated ocularly. In order to study the relative merits of the two methods, a comparison was made on a high summer range in the Wallowa Mountains where four individuals trained in the use of either method estimated by both methods the percent of green fescue (Festuca viridula) removed from 20 plots.

On each of 20 circular plots of 100 square feet, green fescue was clipped so as to simulate natural grazing as nearly as possible, and the forage thus removed was weighed. Each individual, working separately, then estimated the percent of green fescue removed from each plot by the ocular-by-plot method and at the same time measured the average height of stubble left on each bunch. After the estimates and the measurements had been made, the remaining green fescue was clipped to a uniform height of one inch and weighed and the correct percent of forage removed by the first clipping was calculated.

Measurements of the height of stubble were averaged for each plot and the averages converted to percentage removal by referring to a "utilization" table of green fescue based upon 187 plants studied in the immediate vicinity. Results of both methods of estimating percentage removal were compared with the percent actually removed as calculated from the clipped forage weights.

Table 1 gives a comparison of the estimates of utilization as made by the two methods for each of the individuals with the actual removal. The ocular-by-plot method gave the better estimate of the actual removal; also the spread between individuals is not so great by that method as when based upon average height of stubble.

Estimates by the ocular-by-plot method were satisfactorily distributed around the actual percentage removal, having three estimators above the average and one below, whereas those estimates based upon the stubble heights all were low. The fact that the estimates were low can be attributed chiefly to the tendency for examiners to overlook closely utilized parts of a bunch and give too much weight to the parts more lightly used when measuring the average height of stubble. For both methods, highly significant correlations existed between the estimates of forage removal and the actual percentage removed except for one individual when using the height of stubble (table 1).

Table 1.--Variation of estimates of utilization by 4 men on 20 plots

| Men no. | Actual removal percent | Ocular-by-plot method | | | Measurement-"utilization table" method | | |
|---------|------------------------|-----------------------|-------------------|--------|--|-------------------|--------|
| | | Percent removed | Average deviation | r | Percent removed | Average deviation | r |
| | 42.3 | | | | | | |
| 1 | | 37.8 | -4.5 | .941** | 27.6 | -14.7 | .409 |
| 2 | | 46.5 | +4.2 | .693** | 32.6 | - 9.7 | .803** |
| 3 | | 44.0 | +1.7 | .683** | 35.4 | - 6.7 | .858** |
| 4 | | 45.4 | +3.1 | .695** | 37.3 | - 5.0 | .748** |
| Average | | 43.1 | +1.1 | | 33.2 | - 9.0 | |

**Highly significant correlation.

It would appear, from these data, that simple ocular estimates of use of a key grass species when confined to small plots are more accurate than use estimates from measurement of stubble height applied to "utilization" charts or tables. Moreover, the ocular-by-plot method is much faster and simpler to use, both in the field and in the office.

Southwestern

Noxious Plant Control

Snakeweed. The small test plots (.02 acre) at the Jornada Experimental Range, which were subjected to various mechanical and chemical treatments in the latter part of April and repeated again in July (see Monthly Reports for May and June 1938) were carefully examined in late October at the end of the growth season. Data collected consisted principally of plot photographs and snakeweed counts to determine percentage of kill. Recheck counts and data from single dimensional line transects will be secured in the spring of 1939 to determine not only the final percent of snakeweed kill but also the effect of the treatment on other vegetation (principally the perennial forage plants).

In general all treatments were more effective when applied in late July than in late April. Considering a 90 percent or better kill as being satisfactory, only one treatment (grubbing) was effective in April at both stations. Grubbing killed 97.5 percent of the plants at Middle Station and 100.0 percent on the replicate plot at West Station. Burning, spraying with Diesel oil followed by burning, and a 25 percent aqueous solution of sodium chlorate were effective on the plots at the Middle Station but varied from poor to fairly effective on the replicate plots at West Station. Grubbing and burning were effective on all plots treated in July. Sulphuric acid was ineffective in all concentrations on all plots treated. Atlacide was effective in all aqueous concentrations above 5 percent on all plots treated in July. Similarly, sodium chlorate was effective, except on one plot treated with a 10-percent concentration at the Middle Station. In general, borate or sodium chlorate dusting treatments were ineffective on all plots treated during either April or July. Kerosene and Diesel oil were also ineffective. Diesel oil spray followed by burning was effective only on plots treated at Middle Station. Mowing or clipping the plants to a height of 1 to 2 inches resulted in kills varied widely, from 0 percent to 73.2 percent.

Consistently better kills were secured by burning with a flame gun than by igniting snakeweed plants previously sprayed with oil. Variations in percent of kill within similar treatments are likely due to such factors as variation in plant vigor, soil and soil moisture, variation in amount of chemical per plant, the human variation involved in a treatment.

Chlorate sprays secured more effective kills when applied in July than in April. This was probably due to the great difference in plant development. Snakeweed plants treated in April were just emerging from the winter dormancy period. New green shoots were beginning to develop and were less than 1/2 inch long whereas plants treated in late July had approached the climax in vegetative development and were rapidly approaching the blooming stage with flower buds beginning to form.

Since the same treatments are being repeated every three months for the first year, no attempt is made to present relative costs on an acreage basis, although the necessary data are being accumulated.

Preliminary results of mechanical and chemical treatments on snakeweed
(Gutierrezia sarothrae)

| Treatment | Middle Station | | | | West Station | | | |
|---------------------------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
| | Treatments made | | Treatments made | | Treatments made | | Treatments made | |
| | April 28-29 | | July 21-25 | | April 28-29 | | July 21-25 | |
| | No. of plants | %plants killed | No. of plants | %plants killed | No. of plants | %plants killed | No. of plants | %plants killed |
| None (check) | 33 | 3.0 | 19 | 0.0 | 30 | 10.0 | 44 | 6.8 |
| Grubbing | 79 | 97.5 | 39 | 92.3 | 29 | 100.0 | 94 | 94.7 |
| Mowing | 40 | 50.0 | 41 | 73.2 | 41 | 0.0 | 86 | 62.8 |
| Burning | 49 | 91.8 | 42 | 95.2 | 32 | 84.4 | 49 | 93.9 |
| 2.5% H ₂ SO ₄ * | 40 | 12.5 | 41 | 12.2 | 46 | 21.7 | 25 | 8.0 |
| 5.0% " | 42 | 4.8 | 37 | 13.5 | 25 | 4.0 | 79 | 5.1 |
| 7.5% " | 40 | 7.5 | 38 | 21.5 | 36 | 11.1 | 43 | 39.5 |
| 10.0% " | 89 | 14.6 | 38 | 42.1 | 36 | 13.8 | 39 | 53.8 |
| 5.0% Atlacide | 31 | 51.6 | 94 | 85.1 | 34 | 70.6 | 48 | 100.0 |
| 10.0% " | 32 | 30.7 | 64 | 90.6 | 32 | 59.4 | 63 | 93.6 |
| 15.0% " | 81 | 43.2 | 56 | 98.2 | 25 | 84.0 | 49 | 91.8 |
| 20.0% " | 42 | 76.2 | 40 | 100.0 | 27 | 81.5 | 75 | 92.0 |
| 25.0% " | 62 | 82.2 | 62 | 96.7 | 28 | 85.7 | 42 | 100.0 |
| 5.0% NaClO ₃ | 46 | 30.4 | 53 | 77.3 | 25 | 72.0 | 33 | 96.9 |
| 10.0% " | 53 | 52.8 | 70 | 87.1 | 29 | 93.1 | 44 | 95.4 |
| 15.0% " | 72 | 86.1 | 50 | 100.0 | 33 | 84.8 | 53 | 98.1 |
| 20.0% " | 69 | 69.5 | 31 | 100.0 | 43 | 79.1 | 32 | 100.0 |
| 25.0% " | 58 | 94.8 | 59 | 93.2 | 33 | 87.9 | 48 | 100.0 |
| Borate-NaClO ₃ 5:1** | 54 | 79.6 | 49 | 51.0 | 43 | 74.4 | 29 | 86.2 |
| " " 7:1 | 40 | 87.5 | 31 | 83.8 | 15 | 60.0 | 30 | 80.0 |
| " " 10:1 | 50 | 52.0 | 45 | 71.1 | 28 | 35.7 | 45 | 51.1 |
| " " 20:1 | 47 | 19.1 | 42 | 35.7 | 27 | 55.5 | 31 | 58.6 |
| Kerosene | 56 | 14.3 | 45 | 6.6 | 30 | 16.6 | 34 | 14.7 |
| Diesel oil | 56 | 12.5 | 30 | 26.6 | 29 | 17.2 | 39 | 46.1 |
| " " and burning | 37 | 97.3 | 61 | 91.8 | 38 | 47.7 | 84 | 78.6 |

*Concentration expressed as percentage by dry weight.

**Parts borate ore to parts sodium chlorate by dry weight applied as a dust; other chemicals were applied in spray form as aqueous solutions or full strength liquids.

COOPERATING BUREAU PROJECTS

BIOLOGY

(In Cooperation With the Bureau of Biological Survey)

California

Study of Food of Valley Quail. Through the cooperation of the Division of Food Habits Research, Bureau of Biological Survey, a food-habits study has been made for the valley quail of the San Joaquin Experimental Range. Ten quail stomachs were collected per month during the year 1937 and sent to the Division of Food Habits Research for analysis. This work was correlated with plant development notes and forage analyses made by the range forage group.

The 10 most commonly taken food items, with the approximate percent each represented of the total quail food taken, are as follows:

| | |
|---|----|
| Erodium spp. ("filaree") | 20 |
| Trifolium spp. (clover) | 15 |
| Eremocarpus setigerus (turkey mullein) | 11 |
| Lotus americanus ("Spanish clover") | 10 |
| Poaceae spp. (various species of annual grass) | 8 |
| Quercus spp. (acorn fragments) | 4 |
| Plagiobothrys spp. (popcorn flower) | 3 |
| Liliaceae spp. (mostly Brodiaea) | 3 |
| Gilia spp. | 2 |
| Hemizonia spp. (tarweed) | 2 |

Animal food, mostly insects, made up but .5 percent of the total food. Of the remaining 99.5 percent, 27.5 percent was green leaf material and 72 percent was seed or bulb material. The animal food was taken largely during the months of April and May by laying females. Green leaves were taken largely during January, February, and March, with diminishing amounts being taken in April and May. Seeds were taken exclusively in the hot, dry summer, although some succulent species were available. In general, food choice rested on comparative abundance of certain foods, although certain notable exceptions were observed. For instance, clovers, which made up but 1 percent of the total forage on the range in 1937, represented about 15 percent of the quail food, while grasses, which composed 52 percent of the forage by volume, only formed 8 percent of the quail food. It is planned to continue the food study and to publish the results of the 1937 study.

Experiment in Controlled Hunting. An experiment designed to determine the effect of a known hunting rate on a known population of quail is now in progress at the San Joaquin Range. Three pastures totalling 720 acres, which are not grazed during the hunting season, were chosen as a representative area on which to conduct the hunt. Three pastures of similar size and treatment were set aside as a population check area.

These pastures were censused by the standard horseback method on November 8 and 9. The experimental area had 517 quail and the control area 349 quail on this count.

It is planned to take off approximately 25 percent of the birds in the experimental area by hunting. By figuring that the average hunter will get a bag of 8 birds, 16 hunters, chosen by the president of the Madera Sportsmen's Association, are to take part in the hunt. Four hunters participated on November 17, and are to be followed by other groups throughout the season. It is planned to make periodic censuses over the two areas during future years, to determine the total effect of such a cropping rate. Figures on birds per man hour, shells per bird, cripple-kill ration, etc. will be obtained in addition to the routine figures on age, sex, and weight of individual birds. Full crops will be sent to the Biological Survey for food habits study.

Northeastern

Deer Repellent

A cooperative experiment with a simple, quickly applied deer repellent was begun during November on the Childs-Wolcott Estate near Norfolk, Connecticut. Last year's experience indicated that the repellent is very successful, but no attempt to record results was made. The present study involves 3 plots, one fully treated, one with half the trees treated, and one untreated in the midst of heavily used deer cover. Aside from monthly observations browsing measurements will be made in the spring and summer to determine if treatment retards bud development.

ENTOMOLOGY

(In Cooperation With the Bureau of Entomology & Plant Quarantine)

Appalachian

Southern Pine Beetle. Following instructions given by the Bureau of Entomology and Plant Quarantine, control, by peeling and burning, of a southern pine beetle outbreak on the Great Smoky Mountains National Park was carried on by the Park Service in October.

White Grubs. Some infestations in the State forest nurseries at Camden and Georgetown, South Carolina, caused an estimated loss of 66 percent of the pine seedling crop. Indications were that, where properly applied, carbon disulphide had prevented a more serious loss.

Chemical Treatment for Bark Beetle Control and Wood Preservation. Examinations were made at the Bent Creek Experimental Forest of most of the trees chemically treated from 1930 to 1934, inclusive, for bark beetle control and wood preservation. Although some trees were discarded because they did not hold up after treatment, a number were found to be well preserved, and were kept for future inspection. The bark on several of the well preserved trees was extremely tight.

Additional stakes from chemically treated trees were set out for tests of preservation at the Sumter Experimental Forest.

Central States

Walnut Datana. Professor MacDonald reports that infestation was severe in Central Iowa during the past summer. Many walnut trees were being defoliated or partially defoliated in August.

Southern

Termites. Three termite-infested buildings were treated with two chlorinated phenol soil poisons during October.

Inspections were made of several termite-infested houses where sodium arsenite was being used as a soil poison by a commercial termite control operator.

Several buildings were inspected on which were properly and improperly installed metal termite shields; photographs were taken of some of these shields. In some cases the shields had been placed on old buildings constructed many years ago. In one case termites had

constructed tubes on the inner face of the shield but were thwarted by the 45-degree angle turn. Copies of these photographs have been sent to Washington, D. C.

During November one termite-infested building was treated with one chlorinated phenol soil poison; pH records were taken of the soil to be treated. Inspections of houses treated last year were begun and the results tabulated on cards.

PATHOLOGY

(In Cooperation With the Bureau of Plant Industry)

Appalachian

Decay Following Fire. Preliminary analyses of the 1938 field data on the study of decay in hardwoods following fire show a strong correlation between size and age of fire wounds and butt rot in oaks, yellow poplar, and basswood.

Rust Canker. Supervision was furnished to a South Carolina State project in pruning slash pine in plantations. The plantations worked were heavily attacked by rust canker, and the pruning included eliminating limbs with branch cankers which might otherwise spread to the trunks

Northeastern

Sap Stain. In connection with the extensive hurricane damage the progress of sap stain in conifers is being watched. Near New Haven, one month after the storm, blue stain was present one-half inch deep in solid wood of red, white, and Scotch pines. It entered wood exposed by breakage, sawing, or stripping of the bark. Farther north at Keene and at the Gale River Experimental Forest and Cherry Mountain, New Hampshire, the stain is merely on the surface of exposed wood of balsam fir, red spruce, white and red pines, and hemlock. Surface molds only were found on the hardwoods.

Southern

Native Canker-Forming Rusts. The month of October was spent making a more detailed survey of slash seedling infection at the Ashe Nursery in Mississippi, helping direct the CCC pruning work on the Leaf River Unit of the DeSoto National Forest, and in the preparation

and examination of microscopic slides as a check on the identification of rust cankers in the nursery. The results of the survey work at the Ashe Nursery indicate that the rust infection will probably be between 25 and 30 percent in the slash beds which is slightly higher than the figure obtained in the September survey. The results of the microscopic work indicate that rust infection is consistently associated with the swellings used to identify infected plants in the nursery.

In November the survey work was extended into eastern Texas and the Vernon Unit of the Kisatchie National Forest in Louisiana. Observations made in natural reproduction and plantations of various ages indicate that although the rust cankers are generally present in the areas visited, the percentage of infection is low and there is little to indicate that the disease has been or will be a serious problem either on the National Forest Units visited or on state or private land.

Two nurseries were visited in Texas, and one in Louisiana. Examinations showed less than 1 percent infection in one Texas nursery and less than 4 percent in the other two nurseries.

Brown-Spot Needle Blight. A laboratory study was initiated to determine the effect of light and temperature on the germination, growth, and fructification of the fungus causing the brown-spot needle blight of longleaf pine.

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